INSTITUTIONS, ECONOMIC TRANSITION,

AND URBAN LAND EXPANSION

IN CHINA

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ABSTRACT

During the past three decades, China was experiencing a transitional economy driven by both the market and the state. At the same time, the economic transitions brought a tremendous urban land expansion in China and other transitional socialist countries, which drew scholars' attention. This dissertation aims to examine urban land use change, urban land expansion and their mechanisms in Chinese cities in the context of economic transition.

First, this study investigates the relationship between the hierarchical structure of the Chinese urban administrative system and urban land expansion. Urban land expansion coincides with administrative hierarchy, and cities at higher ranks tend to expand more rapidly. Spatial regime models reveal that economic and demographic drivers of urban growth are also sensitive to a city's administrative rank.

Second, we find that the agglomeration phenomenon of proportional increases and regional construction land increase expanded from coastal regions to some key interior cities during 1998-2008. The urbanization is the major driving force for urban land expansion for all the provinces of China, while the industrial adjustment and globalization play the most significant roles in the development of the industrial land use of East China. The decentralization is the most important determinant of transportation land change in South China.

Third, we conduct a case study of Shanghai in China. We find that the development

zones (DZs) are the most significant components of urban growth in Shanghai. Regressions reveal that, though the market has been an important driving force in urban growth, the state has played a predominant role in the implementation of urban planning and the establishment of DZs to capitalize fully from globalization.

Fourth, this study integrates geographical, socioeconomic, and physical factors to explore the underlying patterns and dynamics of urban land expansion in the Greater Mekong Region with an explicit emphasis on institutional conditions. Urban developments in the GMR not only are sensitive to local contexts, such as distance to coastal line, topographic gradient and population growth, but also are closely associated with the country-level factors, such as the political system, economic growth, and foreign investment.

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CHAPTER 1

INTRODUCTION

Research Background

With economic reforms and rapid economic growth during the past three decades, Chinese cities witnessed dramatic urbanization and urban land expansion (Wei, 2012; Wei & Ye, 2014). The urbanization rate increased from 26.0% to 51.3% during the period from 1990 to 2011. The 2011 Revision of World Urbanization Prospects projected that the percentage of urban population in China would reach 73% by the year 2050 (United Nations, 2011). At the same time, urban land expansion in China was more intensive than this demographic urbanization (Bai, Chen, & Shi, 2011). The total built-up area in China increased from 14,391 km^2 to 28,940 km^2 during 1998-2008, with an annual growth rate of 8.07% (CSSB[a], 1999, 2009).

The growth of cities in spatial dimension has received enormous attention both within and outside of academia in previous decades. The discussions on urban growth in developed countries use the term "urban sprawl" to describe the spatial influence of urban land use to other types of land use in the Western context (Ewing, 1997). Gillham (2002) defined urban sprawl as a form of urbanization featured by leapfrog development, commercial strips, low population density, separated land uses, automobile dominance, and a minimum of public open space. However, the urban growth pattern in developing countries always lacks the characteristics of leapfrog and low density (Deng & Huang, 2004). Therefore, the term of urban sprawl is avoiding in this research. On the other hand, urban growth has been defined as the spatial spreading of urban land use, which also has been called as urban expansion. Moreover, in most studies, there is not a significant difference between the definitions of urban growth and urban land expansion. Thus, in this dissertation, the terms of urban growth and urban expansion are used interchangeably.

Literature Review

The body of work on urban land expansion is fragmented. Two broadly defined groups of scholars have been working on urban growth and land use expansion. The first group is more interested in the patterns and mechanisms of urban growth and land use expansion, with neoclassical perspective. The second group is more concerned about the process, mechanisms, and consequences of urban land expansions, following political and institutional economy perspectives.

Neoclassical Perspective

Scholars from the line of neoclassical perspective focus on analyzing patterns and determinants of urban land expansion, within the methods of modeling, geographic information system (GIS), and remote sensing techniques (Brueckner & Fansler, 1983; Luo & Wei, 2009). There are two categories of theories to frame the studies from this perspective: urban bid-rent land model and microeconomic theory.

Urban bid-rent land model, also called “monocentric model,” as the basis of urban economic and macroeconomic theories, explains the accumulated outcome of urban land use change. It theoretically defines the distance to a city center as single determinant of land rents and the resulting distribution of land use. Scholars also incorporate the influence of income, improved transportation system, soil quality, and climate and nature endowments in the bid-rent model. They find that the fundamental economic factors, such as population, income, transportation costs, and agriculture land rent, are primary in determining urban land expansion (Deng, Huang, Rozelle, & Uchida, 2008; Li, Deng, & Seto, 2012; Seto & Kaufmann, 2003).

The microeconomic theory of land use change views the urban land expansion as the outcome of decisions from individual land users, who attempt to maximize the expected profits of individual parcels. Based on the theories of the central place and agglomeration economics, scholars have found that the urban land expansion is driven by the greater gap between land value and rents between urban and rural area (Xie, Fang, Lin, Gong, & Qiao, 2007a). These theories are useful to understand the spatial and temporal dynamics of land use decisions among individual agents (Verburg, Schot, Dijst, & Veldkamp, 2004).

The studies focusing on China also follow above theories developed from the urban experience of western countries to analyze the extent, direction, factors and dynamics of urban land expansion, with a particular focus on accessibility, socioeconomic, and physical conditions (Liao & Wei, 2014; Xie, Batty, & Zhao, 2007b). This line of research can also be divided into two broad categories.

One uses a top-down analytical style, whereby scholars apply statistical approaches to secondary data of the whole nation, such as economic and social factors, to investigate the relationship between economic development and land use change. These studies always have a large scope, for example, all of the prefectural cities in China (Deng et al., 2008; Ding & Lichtenberg, 2010; He, Huang, & Wang, 2013). Moreover, they have found that urban land expansion is highly associated with on economic growth, by gathering the land transferring fee, labor forces, and physical and human capitals. Specifically, significant factors of urban land expansion in China are the growth of gross domestic production (GDP) per capita, foreign direct investment (FDI), and domestic fixed asset investment (Deng, Huang, Rozelle, & Uchida, 2006, 2008; Ding & Lichtenberg, 2011). Scholars have also found that demographic urbanization in China has become a facilitating factor of urban land expansion, rather than a proactive determinant (Bai et al., 2011; Bai, Shi, & Liu, 2014; Fay & Opal, 2000; Zhou & Ma, 2000, 2002).

The other employs a bottom-up style. By applying remote sensing and GIS techniques, these kind of scholars have found that there are strong associations between accessibility, neighbor land use types in a particular city or set of cities (Han, Hayashi, & Cao, 2009; Liu & Zhou, 2005; Luo & Wei, 2009; Schneider & Mertes, 2014). Specifically, based on the case cities of Guangzhou, Chengdu, Nanjing, Beijing, Wuhan and Hangzhou, they have found that the factors such as distance to transportation and central business districts (CBDs), development of mega-projects, development zones and infrastructures, and the increasing value of the real estate in suburban area are the major determinants of urban land expansion in Chinese cities (Cheng & Masser, 2003; Liu et al., 2011; Luo & Wei, 2009; Schneider & Mertes, 2014).

Overall, studies from this perspective have explained the demand and necessaries of construction land increase in China and have promoted our understanding of the urban growth in China by employing the improved spatial modeling techniques and the expanded socioeconomic variables. However, China is still on the stage of the economic transition, and the market system is not consummate (Lin & Ho, 2005). The process of urban land expansion cannot be entirely in accordance with the market principles (Wei, 2012). Urban expansion in China is not just the result of those arbitrary decisions of countless individuals and organizations by the principle of maximizing their benefits in the land market, but subject to certain political and economic structures and social production models (Yang & Wang, 2008; Wei, 2012). It is difficult to achieve a comprehensive explanation of China's urban expansion with the economic theories alone. Hence, explanation of urban expansion only from an economic perspective is oversimplified, which only consider the necessary conditions. This simplification will misguide the land use planning of governments and location decisions of enterprises (Bai et al., 2014).

Methodologically, these studies have made tremendous progress in developing and applying spatial modeling on the land science (Seto & Kaufmann, 2003). However, since their approaches have been more emphasizing on the role of accessibility and the physical environment, the other sufficient conditions, such as the institutional changes and systems, have been missed in these studies. Moreover, for the top-down style, this is also important to incorporate the socioeconomic variables at an appropriate geographical scale (Ma, 2002, 2005). The reasons and underlying mechanism about why the patterns and dynamics vary across different scales are still uncovered. Overall, such studies tend to be more concerned about the progress of methods, and cause the weakness in theorizing and addressing the process of, and forces underlying, urban land expansion especially the impact of macro and institutional forces (Wei & Ye, 2014).

Political and Institutional Perspective

With the rising of the new institutional economics in the 1970s, the scholars have concentrated on the underline social and legal norms and rules of the economic activities. In geography, the institutional scholars are more interested in both institutional environment and institutional arrangement perspectives (Lin & Ho, 2005). To these scholars, urban land expansion is no longer a local and physical process that is mainly influenced by the accessibility and the physical conditions (Wei, 2005). Scholars have argued that the foreign capital brought by the globalization has become a primary impetus of industrial relocation and land development (Wei, 2007, 2012). Based on the globalization theory, scholars have also improved the land change and land system science, by reconceptualizing the process of urban land expansion (Turner, Lambin, & Reenberg, 2007; Verburg, Erb, Mertz, & Espindola, 2013). For instance, the urban land teleconnections framework, proposed by Seto et al. (2012), combined the process of globalization, land use change and urbanization to broad the conventional concept of urban land use change (Guneralp, Seto, & Ramachandran, 2013). Since the economic activities cause the urban land expansion, and due to the rapid development of institutional, economic geography, there are more and more geographers aiming to explain the mechanism of urban land expansion from institutional and political perspectives (Munroe, McSweeney, Olson, & Mansfield, 2014).

The studies from the perspective of political economy and focusing on Chinese cities have analyzed the state-directed process of urban land expansion, often based on case studies and policy analysis (Lin & Ho, 2005; Wei, 2005, 2015; Yang & Wang, 2008). They have adopted the concepts of entrepreneur states, transitional institutions, and growth machine to explain the dynamics of urban development in China (Hall & Hubbard, 1998; Ma, 2002; Sit & Yang, 1997; Wu, 2003). These studies focus on the role of state and their rent-seeking behaviors, and the economic transitions (Lin, 2007; Shen, 2007; Wei, 2012). For the role of the state, Lin and Ho (2005) demonstrated the concept of transitional state in China and analyzed how this transition influences the land management and its impact on urban land expansion. Yang and Wang (2008) focused on the dilemmas of local government, and its effect on the development zone fever in Suzhou. They all have pointed out that the profit from urban land expansion is the central concern for local government officials (Lin, 2007). Ma (2005) found that the urban administrative restructuring and relations between the states also are highly associated with the urban land expansion in China.

Scholars from the institutional perspective have emphasized the evolution of land policies and government function, such as land administration, land property system, land marketization, land revenues, and their influences on the urban land expansion in China (Tan, Beckmann, Berg, & Qu, 2009; Wang, Chen, Shao, Zhang, & Cao, 2012; Xu & Yeh, 2009). In the land property system of China, the ownership of China's land is divided into state ownership and collective ownership. The urban land belongs to the state, while the ownership of rural land is collective. Chinese government developed the compensation system for land acquisition to impose the rural land use right from collective owners. After the local state obtaining the rural land use right from collective owners, they split out the land use right from the land property, and work as the agents who sell the land use right to enterprises, and provide land for investment in industry, commerce, and residential real estate. In the process of urban land expansion, local governments obtain the dramatic economic benefits, which have been called “land revenue” (Tao, Su, Liu, & Cao, 2010; Xu & Yeh, 2009). This revenue consists of three parts: land-transferring fees, rent, and tax based on the land value, and land loans. For instance, in 2012, the land-transferring fee was $440 billion, and the tax for the transfer was $161 billion. The primary reason for such high land revenue in China is that governments devalue the land price when they take it from farmers. The standard of compensation is usually 6 to 30 times the value of its land production during 2011-2014. Because of this huge amount of fiscal revenue and profit, the local governments become enthusiastic about converting farmland into urban usage. From 2001 to 2011, there was 41,100 km^2 farmland requisitioned by municipal officials (CSSB[b], 2001, 2011). To summarize, scholars tend to agree that the changes in the land management and land revenues are the major reason for the rapid urban land expansion in China.

Overall, the studies from institutional and political economy perspectives successfully explain the macro-level underlying dynamics of urban land expansion in China. While plenty of the qualitative and institutional approaches have been applied to these studies, the geographers have introduced the quantitative methods and modeling to enhance the understanding of the mechanisms of urban land expansion. However, since lacking the consideration of socioeconomic, proximity, and physical indicators, all the institutional hypotheses only focus on the necessary conditions for studying urban land expansion in China. The understanding and interpretation of the fundamental mechanism of this development are still insufficient (Wei & Ye, 2014).

Summary

Several areas still need further research efforts. First, most the urban growth models mainly include physical and proximity variables. However, since the urban growth is caused by human activities, it is important to include more socioeconomic and institutional factors to develop integrated models. Even if there are plenty of challenges and difficulties in quantifying social, economic, and institutional forces, the efforts that attempt to bridge the quantitative and qualitative research will provide a complete understanding of the complexity of urban growth. In this dissertation, we quantitatively identify how the administrative system affects urban land expansion in all prefectures of China. Moreover, we also attempt to explore the impacts of interactions between market and state forces in selected cities.

Second, the measurement of urban land expansion is monotonic, which cannot cover the influence of the structural advantage and national development. More studies are needed to focus on the subcategories of construction land use change and the differences in their underlying determinants (He et al., 2013). Therefore, this dissertation comprehensively and quantitatively investigates the regional disparities and dynamics of industrial, transportation, and urban land use change in China.

Third, most orthodox land use models only reveal urban growth patterns from a global view, but the same set of underlying factors may produce various effects in different subregions of one city. Exploring the spatially varying relationships between land use change and influence factors helps to achieve a better understanding of the inherent spatial heterogeneity of urban growth patterns. In association with the critique of grand theories and macro models, local and spatial variations in urban growth should attract scholarly attention. The models we used in this dissertation reveal not only the spatial heterogeneity of urban land expansion but also the geographical variations of underlying dynamics of the urban growth in China at different scale levels and with the different land use types.

Fourth, although most of the studies on urban growth in China have dealt with the most rapidly growing eastern cities and regions, such as the Yangtze River Delta (Luo & Wei, 2009; Xie et al., 2007b), the Pearl River Delta (Yeh & Li, 1998), and Beijing (Wu et al., 2006; Xie et al., 2007a), there are very limited studies on the leading global city, Shanghai. In this dissertation, by analyzing the spatial patterns and dynamics of urban land expansion in Shanghai, we contribute more understanding about how the interactions between globalization and localization reshape urban growth in Chinese global and globalizing cities.

Fifth, scholars have found that the economic transition will cause a dramatic urban expansion in the socialist countries (Wei & Ye, 2014). However, because of lacking the comparison with capitalist countries, the advantages of transitional socialist countries in the urban expansion are still uncovered in current literature. Although some other socialist countries have replicated Chinese development pattern and path, there are few studies applying China's context-specific theories on explaining their urban expansion.

Research Objectives

According to the background mentioned above, China's urban land expansion needs more investigations at different geographical scales and scopes, such as an individual city and all prefectures of the nation. From a combined perspective of both the institutional and the neoclassical theories, by considering some specific institutional components, such as the administrative system, state power, and economic transitions, this paper aims to fulfill the following research objectives:

1. Contributes a quantitative understanding of the link between the administrative ranking of a city and the magnitude of urban land expansion in China, and finds out that how a city's rank affects other drivers of urban land expansion, such as capital flow and urban-rural migration.

2. Comprehensively and quantitatively investigates the regional disparities of subcategories of construction land use change China, and highlights the dynamics of regional changes of these land use in the context of economic transition of China, by controlling the effects of geographical locations.

3. Assesses the extent and the spatial patterns of urban land expansion in Shanghai, and investigates the interaction between the development of urban land and accessibility, state policy/planning and neighborhood land use to understand the mechanisms of urban growth better, and to quantify the interactions between state and market powers comprehensively.

4. Integrates geographical, socioeconomic and physical factors to explore the underlying patterns and dynamics of urban land expansion in the Greater Mekong Region with an explicit emphasis on institutional conditions, and discovers how the various political systems affect urban expansion in developing countries.

Analytic Framework: Triple-Processes of Economic Transition

Economic transition has significantly promoted economic growth and induced impressive urban transformation in China by introducing new elements of development in China. This transition has altered in significant ways how China uses its land, leading to the significant urban development and land use change (He et al., 2013). This dissertation aims to analyze how the institutional forces and economic transition, particularly government structure and policies, affect urban land expansion in China. Wei (2001) generalized the triple transition of economic transition analyzing the economic growth in China: decentralization, marketization, and globalization. Since all the institutions and institutional changes in China are guided and influenced by the economic transition, we adopt the framework of triple-transition to explore the underlying dynamics of urban land expansion in China in this dissertation. Decentralization grants more authority to local governments to develop the land market to promote their fiscal income, while marketization promotes the development of the land market and private enterprises to increase the land supply (Huang, Wei, He, & Li, 2015; Li, Wei, Liao, & Huang, 2015). Globalization, characterizing by the foreign direct investment (FDI), causes the development zone fever in China (Carter, 2001), and increases the land demand.

Decentralization of Decision-Making

China's reform has reconfigured the relationship between state and market, and between domestic and global forces. Similar to the global process of state decentralization, in response to the over centralization of state socialism, China's reform started with decentralization. China's decentralization transfers the planning and decision-making authority from the central government to local government (Wei, 2001). Decentralization has taken place in China's fiscal system and financial systems and has promoted the investment activities and enterprise management. With the reform of the fiscal system, local governments have been motivated to secure extra-budgetary revenues, and the land revenue has become the major strategy for local states to obtain the extra-budget (Ding, 2007; Lin & Ho, 2005; Liu, Tao, Yuan, & Cao, 2008). Chinese local states have become agents of urban development to provide land for the investment in industries and real estates (Ma, 2002; Ng & Tang, 2004). On the hand, decentralization has also provided local states more powers to mobilize the state-owned land and state-directed projects for urban growth. Local governments reap the benefits of low-cost land use under the current land administrative system, by controlling the supply side of industrial and commercial land uses (Ding, 2007). By providing land at a very low leasing price, local governments strive to attract industrial investment through land development (Lin, 2007). Consequently, local governments develop industrial parks and open zones, resulting in more land development (Deng, Lin, Zhan, & He, 2010; Yang & Wang, 2008). Therefore, by promoting the establishment of the land market, decentralization is a key source of urban land expansion in China.

Marketization of Coordination Mechanism

We demonstrate the relaxed state control and the increasing importance of market mechanisms in economic development in many aspects. First, the control of the state budget over the economy has declined. Second, marketization has established numerous financial institutions and market instruments. Third, state control over investment has declined. Fourth, the marketization has dramatically reduced state control over price, by reforming the price system. Last, marketization has caused the reduction of shares of output and labor absorption by state-owned enterprises (Wei, 2001). Based on these approaches, China has introduced market forces into urban development. First, with the introduction of the market economy, the economic value of land has been gradually recognized in China, and the demand for land has been rising, including foreign investors seeking land for their projects and rural–urban migrants looking for basic housing in cities. Second, the marketization promoted the establishment of the land market (Qian, 2008). The 1988 Constitution was the first national law that legalized the separation of land ownership from land use right, and it also allowed the transference of land use right (Zhang, 2000; Zhu, 2005). The State Council passed the Regulation of Urban Land Use Rights in 1988 and enacted the regulation in 1990. Although there is still no privately owned land in China, the central still established a land market for transferring the land use right in 1987. Land market satisfies user demand for land from overseas investments and local businesses and constitutes a vital revenue source for the local state (Li, 1999; Zhu, 2005). Therefore, marketization is a key driving force of urban land expansion in China.

Globalization

The Chinese state also acts within the context of globalization. The strategies of globalization in China could be divided into two categories. The first one is developing the special economic zones (SEZs) and development zones (DZs) to attract FDI, while the latter one is based on the open door policy, to participate the international financial market. The major purpose of China's open-door policy is to accumulate global capital through attracting FDI and selling Chinese exported products. Globalization can cause urban land expansion in many ways. First, with the influence of global market forces, the reform of China's land system takes place first in special economic zones and coastal open cities, with the gradual establishment of the land market (Lin & Ho, 2005). Second, to attract FDI and promote exportation, local governments have tremendous interest to establish development zones to promote local development (Han, 2010; Su, 2005), known as development-zone fever (Cartier, 2001; Wei & Leung, 2005).

Third, as the effect of globalization, cities have attempted to improve infrastructure, central business districts (CBDs), and research and design (R&D) facilities to attract FDI and other global resources. For example, global expansion of business activities has intensified the need for the development of command and control functions in the CBDs. CBDs, together with specialized nodes or subcenters constitute the spatial structure of cities. CBD development and expansion are another major component of urban development in China. Fourth, globalization has also intensified the development of within the knowledge/technology economy, which enforces local states to develop more and higher education districts and high-tech zones (Wei, 2012). Fifth, the development of globally oriented mega projects is also another important feature of urban land expansion in China. For instance, the 2008 Beijing Olympics significantly improved the development of airports and high-speed railway. All of these efforts and policies based on globalization have greatly contributed to the urban development and urban land expansion.

Data and Methodology

Study Area

With rapid economic growth during the past three decades, Chinese cities have experienced dramatic urbanization and urban expansion. The year 2011 was a milestone in history when more people in China lived in cities and towns than in the countryside. By the end of 2011, China had a total urban resident population of 691 million, comprising 51.3% of its total population, up from 26% in 1990 (CSSB[a], 2012). In the course of this unprecedented urbanization, urban land expansion in China has been even more intensive than demographic urbanization (Bai et al., 2011), and the total built-up area in China increased from 14,391 km^2 to 28,940 km^2 during 1998-2008, with an annual growth rate of 8.07% (CSSB[a], 1999, 2009). Therefore, we choose all the 283 prefectures as our study area, which involves 265 prefecture-level cities, 4 centrally controlled municipalities, and 15 subprovincial level cities.

Under the background of urban growth in Chinese cities, this study also conducts a case study by investigating the mechanism of urban growth in eastern Shanghai on the individual city scale, from 1991 to 2010. The most important reasons for choosing Shanghai as a case study in this research are its special historical, geographical, social, and economic characteristics, as well as the lack of attention paid to it in the existing literature (Li, Wei, & Huang, 2014; Wu, 2000). Shanghai, a leading global city in China and the “dragon’s head” of the Yangtze River Delta, has been undergoing significant urban growth since 1990 when the central government established the Pudong New Area. Between 1993 and 2009, the city’s built-up area increased from 300 km^2 to 886 km^2, with a 6.5% annual growth rate (SSB, 1994, 2010). The land development of Shanghai is the result of interactions between market and state, and global and local forces (Han et al., 2009; Timberlake, Wei, Ma, & Hao, 2014; Wu, 2000). Given its massive urban population and land area, as well as its sensitivity to global change, a better understanding of urbanization and land expansion in Shanghai is critical to the development and sustainability of megacities in China.

To test our findings and hypotheses developed from the case of China, we also select the Greater Mekong Region (GMR) as our study area, which has two provinces in China and five independent countries, namely Cambodia, Laos, Myanmar, Thailand, Vietnam, the Yunnan and Guangxi Provinces of China. As a natural economic area bound together by the Mekong River Basin, the GMR witnessed a dramatic urban growth in both demographic and landscape dimensions. From 2000 to 2010, the total urban population of this region increased from 38.5 million to 61.7 million, with an annual growth rate of 4.84% (World Bank, 2015). The total built-up area of the GMR increased from 14,311.80 km^2 to 17,427.95 km^2 from 2000 to 2010, and the annual growth rate was 1.99% (World Bank, 2015). Given the massive inhabitants of this region, as well as its various political systems (Krongkaew, 2004), a better understanding of urban expansion is critical to the urban development and sustainability of other developing countries in Asia.

Data

Data acquired for this study include land use change statistics, socioeconomic data, planning maps, reports of development zones, GIS spatial files, and the remote sensing images. The majority of land use data in China are collected from the records of Ministry of Land and Resources (MLR), which document land conversion between urban and nonurban areas in detail from 1998 to 2008. The dataset from MLR is only official data of land use change in China (He et al., 2013). For the Greater Mekong Region, the data on urban land use and urban population in 2000 and 2010 are collected from the World Bank East Asia and Pacific Urban Flagship Study (PUMA).

Socioeconomic data are collected from the statistics of the Chinese government, from different department and bureaus, including the China Urban Construction Statistical Yearbook (CSSB[b], 1998-2010), China Urban Statistical Yearbook (CSSB[a], 1998-2012), Shanghai Statistical Yearbook (SSB, 1991-2010), China Data Center, International Monetary Fund (IMF), World Bank, and United Nations (UN). The vector spatial data are mainly obtained from Shanghai Planning and Land Resources Administration, the China Academy of Urban Planning, China Data Center, and World Bank, and the range of planning area and development zones are extracted from the georeferenced hard copy maps by digitizing.

The satellite images used in this dissertation include the images of Landsat TM 5, SPOT 2 and 5 in 1991 and 2000 for Shanghai. The TM images are collected from the U.S. Geological Survey (USGS), while the SPOT 2 and 5 are collected from the Center for Modern Chinese City Studies at East China Normal University. The other raster data such as digital elevation model (DEM) with a resolution of 90 meter and annual average precipitation surface with a resolution of one-degree latitude-longitude grids are collected from U.S. Geological Survey (USGS) and Global Precipitation Climatology Project (GPCP), respectively.

Analysis Methods

To explore the trends, mechanisms, and consequences of urban land expansion in Shanghai, China, and the Greater Mekong Region, I employ various analysis methods in this dissertation, including remote sensing, spatial statistical, and GIS techniques.

First, a set of spatial-temporal regression models is furnished for understanding the urban administrative hierarchy and heterogeneity of urban development mechanisms. The dissertation starts with a panel data regression and ordinary least squares (OLS) of underlying factors behind the urban expansion in China. This is followed by the spatial regime regression used to probe the spatially varying development mechanism in all Chinese prefectures (details about this method are discussed in Chapter 2).

Second, we introduce the shift-share analysis to study the structural change and regional advantage of construction land change in all 283 prefectures in China. To estimate the spatial autocorrelation and spatial relationships among prefectures in China, the indexes of Moran's I and local Moran's I are employed. It is followed by two spatial regression models (spatial lag regression and geographically weighted regression), to consider the spatial effects including spatial autocorrelation and heterogeneity on regional construction land use change in China. The underlying the linkages between economic transition and different types of construction land change in China are revealed by these models (details about this method are discussed in Chapter 3).

Third, the maximum likelihood classification method is employed to investigate the scale and extent of construction land expansion for Shanghai from 1991 to 2010. The GIS technique is used to extract the independent variables for regression. Then, a landscape metrics-based analysis is carried out to analyze the temporally sensitive land use images in Shanghai. The three types of urban growth (i.e., infill, leapfrog, and edge-expansion) are differentiated. Furthermore, a spatial logistic approach (spatial logistics regime regression and geographically weighted logistic regression) is developed to model the spatial variations of temporal changes in land use change (details about this method are discussed in Chapter 4).

Fourth, to consider the natural spatial heterogeneity caused by the various political systems, we apply the multilevel modeling to explore the determinants of urban land expansion of the Greater Mekong Region. Multilevel modeling overcomes the limitation that recognizes the existence of data hierarchies by allowing residual components at each level in the hierarchy (details about this method are discussed in Chapter 5). The application of multilevel modeling attempts to separate the effects of national and county levels factors on Greater Mekong Region's urban expansion. Furthermore, considering the influences from spatial autocorrelation, we apply the GWR model to reach more locally detailed and geographical differences between factors.

Organization

I organize this research into six chapters. Following this introductory chapter, Chapter 2 advances the significant role of institutions in the land development in Chinese cities by using the most recent and available statistical data. By choosing the construction land use as the indicator of urban land expansion, this chapter analyzes the interactions between the administrative system, demographic urbanization, economic transitions, and urban land expansion with GIS and statistical techniques. The spatial regime and geographically weighted regressions are used to examine the different dynamics of urban land expansion in Chinese cities across the administrative hierarchy.

Chapter 3 explores the changes of three specific land use types: industrial land, transportation land, and urban land, which belong to the category of construction land use. By introducing the shift-share analysis, this chapter examines the regional change of these three types of land use. We employ GIS-based spatial statistical methods, the spatial lag regression, and GWR to examine spatial patterns and determinants of regional construction land use changes. Chapter 4 turns to a case study and investigates the urban land expansion in Shanghai. The model adopted in this chapter is based on the integration of remote sensing, geographic information system, and spatial econometrics. We examine the construction land expansion in development zones of Shanghai. Different from the debate of market and state, we quantitatively investigate how these two driving forces influence the urban land expansion in Shanghai.

Chapter 5 expands our findings and framework to other developing countries. We integrate geographical, socioeconomic and physical factors to explore the underlying patterns and dynamics of urban land expansion in the GMR with an explicit emphasis on institutional conditions. Chapter 6 discusses and concludes the research significance of this research, and highlights the directions of future studies.

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CHAPTER 2

ADMINISTRATIVE HIERARCHY AND URBAN LAND EXPANSION IN TRANSITIONAL CHINA[1]

Abstract

This chapter investigates the first research question mentioned in Chapter 1, emphasizing the relationship between the hierarchical structure of the Chinese urban administrative system and urban land expansion. Based on the official land use change data from 1998-2008, we find that urban land expansion coincides with administrative hierarchy and cities with higher administrative levels (ranked by central government) tend to expand more rapidly while controlling for other economic and demographic drivers of urban expansion. Spatial regime models reveal that economic and demographic drivers of urban growth are also sensitive to a city's administrative rank. By quantifying the link between a city's rank and urban land expansion, we conclude that considering the hierarchical structure of the Chinese cities will result in a fuller understanding of the rapid urban growth in China.

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[1] Adapted from Li, H., Wei, Y. H. D., Liao, F. H. F., & Huang, Z. (2015). Administrative hierarchy and urban land expansion in transitional China. *Applied Geography*, *56*, 177-186.

Introduction

With rapid economic growth during the past three decades, Chinese cities have experienced dramatic urbanization and land expansion. The year 2011 was a milestone in history when more people in China were living in cities and towns than in the countryside. By the end of 2011, China had a total urban resident population of 691 million, comprising 51.3% of its total population, up from 26% in 1990 (CSSB[a], 2012). The urban resident population in Chinese cities is expected to increase to 70% by 2035 (CSSB[b], 2008). In the course of this unprecedented urbanization, urban land expansion in China has been even more intensive than demographic urbanization (Bai, Chen, & Shi, 2011), and the total built-up area in China increased from 14,391 km^2 to 28,940 km^2 during 1998-2008, with an annual growth rate of 8.07% (CSSB[a], 1999, 2009).

A rich body of literature has already been produced to uncover the causes of urban land expansion in Chinese cities. Scholars have found that urban land expansion has been driven by a rapid growth of nonagricultural activities and economic growth (Bai, Shi, & Liu, 2014; He, Huang, & Wang, 2013; Liao & Wei 2014; Yuan, Wei, & Chen, 2014). By emphasizing the transforming political economy in China, recent studies have paid more attention to the impact of local states on urban land expansion in China, addressing the notions of local state corporatism, growth machines and entrepreneurial states (Ma, 2002, 2005; Wei, 2012; Xu & Yeh, 2009; Yang & Wang, 2008).

On the other hand, the decentralization of decision-making in China is hierarchical and uneven. In the urban administrative system of China, cities have different ranks represented by the notions of direct-controlled municipalities, subprovincial cities, and prefectural level cities (Ma, 2002). The administrative ranking of a city represents the power of local government in China; higher administrative ranks tend to correspond to stronger policy-making power and larger administrative territory for land conversion, which is also represented by the level of autonomy of their land use planning (Chen, 1991; Ma & Fan, 1994; Ma, 2002, 2005; Shen, 2007). Furthermore, higher-ranking cities are more likely to attract investments from the central government and also from abroad (Chen & Partridge, 2013). For instance, in the case of Guangzhou city, Xu and Yeh (2005) found that new urban development has greatly benefited from Guangzhou being the capital city of Guangdong province. Other researchers also found that urban land expansion in Hangzhou, the capital city of Zhejiang province, has been fueled by the annexation of neighboring suburban counties (e.g., Zhang & Wu, 2006). In the literature on Chinese urban growth, the association between a city's political status, especially the city's administrative rank and its momentum of economic growth as well as urban land expansion, tends to be self-evident (Xu & Yeh, 2009). However, as Lin, Li, Yang, and Hu (2015) argued, the reshuffling of state power in Chinese urban land development is often treated as an elusive variable. Relatively fewer studies have been done to quantify the exact relationship between a city's rank and its magnitude of urban land expansion, to better understand rapid urban growth in China.

Based on more reliable official land use data in Chinese cities, this chapter aims to contribute a quantitative understanding of the link between the administrative ranking of a city and the magnitude of urban land expansion in China. As this research will demonstrate, a higher administrative rank, corresponding to stronger policy-making power and larger administrative territory for land conversion, often results in a more extensive urban land expansion. By applying such spatially explicit methods as spatial regime regression, the study shows that a city's rank can also have a profound impact on other drivers of urban land expansion, such as capital flow and urban-rural migration.

In the following sections, we review the pertinent literature and previous works on urban land expansion in the context of China's economic transition. This is followed by a comprehensive analysis of patterns of urban land expansion with explicit attention being given to different administrative level cities. Secondly, several regression models, particularly spatial regime models, are applied to test the hypothesis that a Chinese city's expansion can be associated with its administrative level/rank while the driving forces of urban land development are heterogeneous in the Chinese urban administrative system.

Literature Review

Economic Transition and Urban Land Expansion in China

Urban expansion and growth in China are by no means disconnected with dramatic economic and political transitions over the past three decades (Li, 2005; Ma, 2002, 2005; Xu & Yeh, 2009; Yang & Wang, 2008). As Chinese cities transformed from socialist cities to postsocialist cities, the triple transitions of marketization, decentralization, and globalization are driving Chinese urbanization and urban land expansion (Wei, 2007, 2012). As one of the most significant features of socialist reform, marketization, and the reform of the land market have made land one of the most important instruments that enable local states to accumulate wealth and to develop infrastructures and other public facilities (Tao, Su, Liu, & Cao, 2010). Under marketization, the land is regarded as a unique and very significant resource for local revenue (Qian, 2008). Also, decentralization of economic governance grants local states autonomy to plan their cities and promote urban land expansion (Ma 2002; Xu & Yeh, 2009). As one of the most representative policy instruments, development zones (DZs), have been one of the most significant components of urban development strategies in Chinese cities (Cartier, 2001; Ding & Zhao, 2011; Tao et al., 2010; Wei, 2012; Wei & Leung, 2005; Yang & Wang, 2008). In 2011, there were more than 6,500 DZs in China. At the same time, globalization, symbolized by the huge flow of foreign development, has provided more incentives for local states to integrate going global and developing DZs in their urban land use planning, coined as “new town fever” in Chinese cities (Ding & Zhao, 2011; He et al., 2013; Ma, 2002; Wei, 2005; Wei & Leung 2005).

As the process of economic transition spreads across the Chinese cities (Bloom, Canning, & Fink, 2008; Brueckner, 2000; Xu & Zhu, 2008), researchers have characterized urban expansion as an outcome of economic growth (Deng, Huang, Rozelle, & Uchida, 2008; Seto & Kaufman, 2003). Moreover, in the process of urbanization, cities attract rural populations, which lead to large urban land expansion (Bloom et al., 2008; Seto, Fragkisa, Guneralp, & Reilly, 2011). Other works also found massive migrations from rural areas have resulted in more demand for construction land for residential use (Wei, 2005). Notably, recent studies further the debate regarding urban land expansion in China by considering the specific political economy of land development (Li, 2005; Yue, Fan, Wei, & Qi, 2014). The detailed structure of the urban administrative system (Ma, 2002, 2005), land governance (Xu & Yeh, 2009), growth pole (Zhang & Wu, 2006), hierarchical system rebuilding process, and decentralization of power in China (Ma & Fan, 1994; Wei & Zhao, 2009), also have contributed to a better understanding of how the local state can play a proactive role in Chinese urban land expansion.

Administrative System and Urban Land Expansion in China

In most developing countries, a land administrative system is a strategic component of land policy and is intended to reform the economic system, decrease injustice, rebuild the government system and eliminate poverty (Steudler, Rajabifard, & Williamson, 2004; Williamson, 2001). The specific question about administrative ranking and urban expansion in China is legitimate since Chinese cities are institutionalized under different administrative authorities. For instance, only four provincial-level cities have limited legislative power of land administration. On the other hand, the lower-level cities are more strictly controlled by the central government through the land administrative system. In the context of China's economic transition that began in 1978, an establishment of the land use principle of legitimacy was implemented as part of the reshuffling of power relationships between states at different levels (Castells, 2000). The process is specifically characterized by tiered political and economic power structures in the national hierarchical system (Ma, 2005).

Because of its relatively inflexible hierarchical structure, the rank-based urban administrative system in China is quite different from that of Western countries and has a strong effect on local development (Bennett, 1997). Local land use planning and land administration are mainly implemented through the urban hierarchy administrative system, which is how the significant driving forces of the land development are influenced by the urban hierarchical system or a city's rank. Surprisingly, the literature on the role of urban hierarchy in China's urban and regional development is limited (Chen & Partridge, 2013; Ke, He, & Yuan, 2014), but as found in Ke and Chen, urban hierarchy has become a key lens better to understand the uneven economic growth and regional development in China. This study continues to focus on the hierarchical structure of the Chinese urban administrative system with the aim of shedding further light on the urban land expansion in China.

An Analytical Framework

To comprehensively investigate the relationship between urban hierarchy and land expansion in transitional China, we proposed the use of an analytical framework better to summarize the dynamics of urban land expansion (Figure 2-1). First, as the result of the economic transition, Chinese cities have made spectacular achievements in economic growth and industrialization as well as capital accumulation, which are the primary drivers of urban land expansion (Hsing, 2006; Li, 2003; Ping, 2011; Wei, 2007; Wei & Lin, 2002; Wu, 2003; Xu, Yeh, & Wu, 2009). Specifically, significant factors of urban land expansion in China are the growth of gross domestic production (GDP) per capita, foreign direct investment (FDI), and domestic fixed asset investment (Deng, Huang, Rozelle, & Uchida, 2006, 2008; Ding & Lichtenberg, 2011; Liu, Zhan, & Deng, 2005). In the context of a rapid urban economic growth and economic transition, scholars have also found that demographic urbanization in China has become a facilitating factor of urban land expansion, rather than a proactive determinant (Bai et al., 2011; Bai et al., 2014; Fay & Opal, 2000; Zhou & Ma, 2000, 2003).

Second, as illustrated in Table 2-1, there are three basic administrative levels for cities in the Chinese urban administrative system, which presents quite diverse levels of administrative power in local affairs. A prefecture is the third level of this system, and it is the level for most major cities in China.

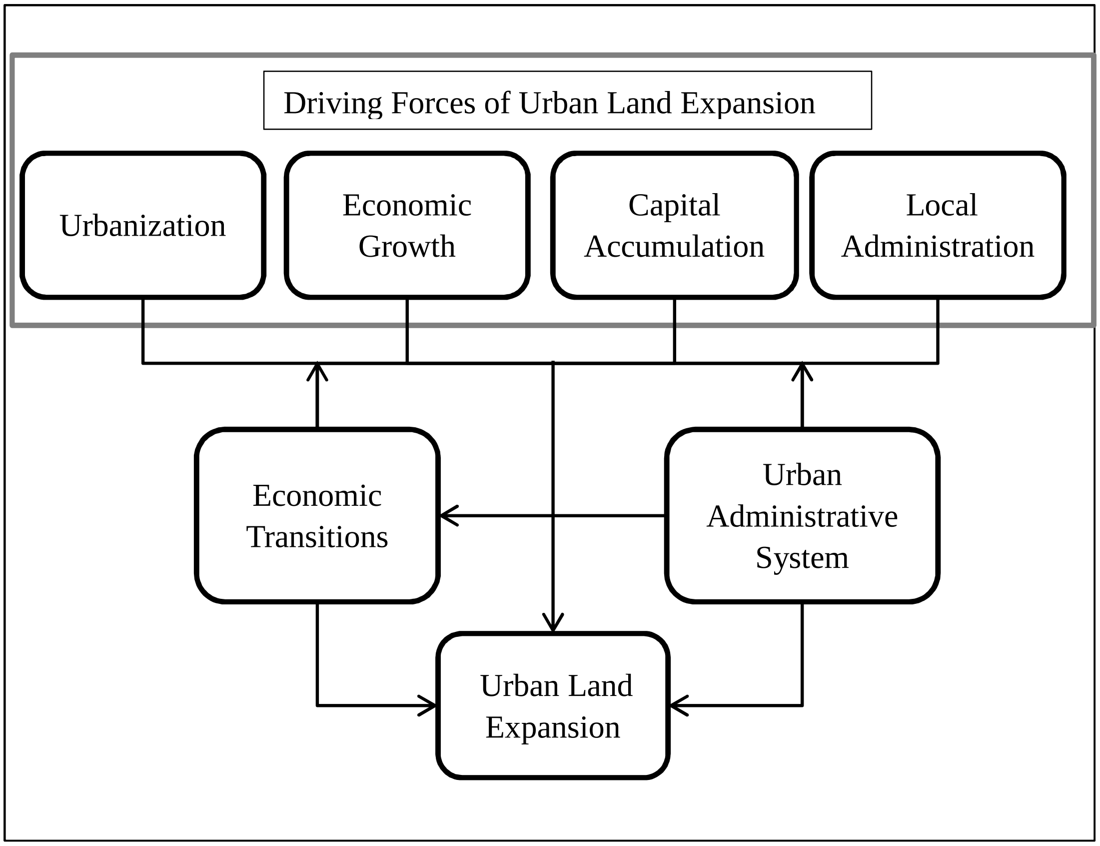

Figure 2-1 Analytical framework to urban hierarchy and urban land expansion

Table 2-1 Urban administrative system in China in 1998, 2002, 2003 and 2008

Administrative Levels	City Title	1998	2002	2003	2008
Provincial Level	Centrally Municipalities	4	4	4	4
Vice Provincial Level	Designated in the State Plan	5	5	5	5
	Vice Provincial Capitals	10	10	10	10
Prefectural Level	Prefectural Cities	208	261	263	268

Source: China Urban Statistical Yearbook (1999, 2003, 2004, and 2009)

Since 1998, the number of prefectural level cities has increased from 208 to 261 in 2002 and to 268 in 2008 (including Lhasa) (CSSB[a], 1999, 2003, 2004, 2009).

Third, the urban administrative system has reinforced the uneven distribution of economic resources and other impetuses underlying urban growth in Chinese cities (Chen & Partridge, 2013). For example, there are different levels of DZs in China, with differentiated preferential policies, sizes, and tax subsidies. National level DZs are mostly established in higher-level cities such as direct-controlled municipality and subprovincial capitals (Ke et al., 2014). Besides development zones, the urban hierarchy is closely linked to local economic development policy in China. Recent studies have proved that policy-driven development strategy has divided cities into several categories of foreign investment targets. Higher-level cities attract more foreign investment than prefectural cities due to their relatively preferential and better-developed environment (Cheng & Yum, 2000; Feng, 2011; Wang, Gu, Tse, & Yim, 2012a). In this research, we hypothesize that a city's administrative rank should be one of the most significant instruments of urban land expansion in transitional China. Furthermore, we also assumed that different drivers of urban land expansion in China are sensitive to the administrative hierarchy.

Data and Methodology

Data

The data used in this study are mainly gathered from the record of land use from the Ministry of Land and Resources (MLR, 1998-2008), and complemented by China's Urban Statistical Yearbooks (CSSB[a], 1999-2012), and China's Statistical Yearbook of Regional Economy (CSSB[c], 2000-2010). Using the fixed price consumer price index reported by China's National Bureau of Statistics (2011), all monetary values are corrected for inflation to the constant 2010 level. As the most significant indicator of urban growth in China, the construction land use data are derived from the data collected by the MLR, which are originally from the first national land survey in 1996 (He et al., 2013). The data were officially confirmed in 1998 and had become the base of official land use change data. This dataset has been updated by the MLR annually at the county level (Lin & Ho, 2005; Wang, Chen, Shao, Zhang, & Cao, 2012b). We have to point out that this data may underestimate the urban growth in Chinese cities because some illegal land use changes are not involved. Nevertheless, this dataset is the only official land use data available from the Chinese government.

Regression Analysis

Some scholars have posited land expansion in city j at time t (G_{jt}) as a function of economic development (E_{jt}), labor (N_{jt}), capital (K_{jt}), and government-provided services (S_{jt}), unique to each city (A_j) and period (U_t) (Ciccone & Hall, 1996; Dekle & Eaton 1999). Based on the existing literature, we added more factors in the following equation to adapt to the unique situation of Chinese cities:

$$G_{jt} = F(E_{jt}, P_{jt}, L_{jt}, S_{jt}, A_j, U_t) \qquad \text{(Eq. 2-1)}$$

Where (G_{jt}) is land expansion in city j during time t; (E_{jt}) is economic development; (L_{jt}) is local state power; (P_{jt}) is population growth; (S_{jt}) is government-provided services, unique to each city (A_j) and period (U_t).

Following Eq. 2-1, we applied to panel data regression on all observations (501), and ordinary least squares (OLS) regression for 227 and 274 prefectural level cities for the periods from 1998 to 2002 and 2003 to 2008, respectively (CSSB[a], 1998, 2009). It should be noted that the construction land data before and after 2002 are incomparable because the Ministry of Land and Resources changed the statistical criteria during 2002-2003.

To examine the different mechanisms of urban land expansion in 19 higher-level cities and lower-level cities, we employed the spatial regime models, a technique that can explicitly recognize the heterogeneity of land expansion mechanisms in different levels of cities. More specifically, the spatial regime model is a technique that can derive the parameters that are specific to cities in particular groups/spatial regimes. This model has been widely used in planning, political, urban, and geographical studies (Cravo & Resende, 2013).

In our model, by addressing the difference between prefectural level cities and subprovincial and direct-controlled municipality in China, land expansion mechanisms in Chinese cities are assumed sensitive to their administrative ranks. As shown in the Eq. 2-2, we allowed the coefficients to vary across two different political regimes: a regime of prefectural level cities (*A*) and a regime of higher-level cities (*B*)

$$\begin{bmatrix} gr_{i,tA}^{*} \\ gr_{i,tB}^{*} \end{bmatrix} = \begin{bmatrix} Y_{i,t-1A}^{*} & X_{i,t-1A}^{*} & 0 & 0 \\ 0 & 0 & Y_{i,t-1B}^{*} & X_{i,t-1B}^{*} \end{bmatrix} \begin{bmatrix} b_A \\ \varphi_A \\ b_B \\ \varphi_B \end{bmatrix} + \begin{bmatrix} v_{i,tA} \\ v_{i,tB} \end{bmatrix} \qquad \text{(Eq. 2-2)}$$

Where the subscripts *A* and *B* indicate different regimes; $gr_{i,tA}^{*}$ and $gr_{i,tB}^{*}$ are $N \times 1$ column vectors with observations for construction land use change for spatial regimes *A* and *B*, respectively; $Y_{i,t-1A}^{*}$, $Y_{i,t-1B}^{*}$ are $N \times 2$ matrices including the constant term and initial construction land change of each regime; $X_{i,t-1A}^{*}$, $X_{i,t-1B}^{*}$ are the $N \times K$ matrices of observations on other explanatory variables for each regime;

$v_{i,tA}$, $v_{i,tB}$ are the $N \times 1$ vectors of error terms (Anselin, 1999; Cravo & Resende, 2013; Ramajo, Marquez, Hewings, & Salinas, 2008).

Variables

According to our analytical framework (Figure 2-1), variables representing city ranks, economic, and demographic drivers, and the proxy of local state power are applied in this model (Table 2-2). Furthermore, following He et al. (2013), specific variables employed are lagged for 4 years in the model of 1998-2002, and for 5 years in the model of 2003-2008 to address the issue of endogeneity.

The change of construction land area (1998-2002 and 2003-2008) for all prefectural-level and upper-level cities from MLR is used as the dependent variable to measure the urban land expansion in China (Ding & Lichtenberg, 2011; He et al., 2013).

For the city ranks, the variable for direct-controlled municipalities (DM) and subprovincial cities (DV) (1998 and 2003) is a dummy variable that measures whether the city's administrative level is provincial level or subprovincial level. For DM, 0 means the city is not a municipality, and one means the city is a municipality. For DV, 0 represents a prefectural level city or a municipality, and 1 represents that the city level is subprovincial.

From the socioeconomic perspective, the log of (Domestic Fixed Asset Investment) (FAI) (1998 and 2003) is selected to represent whether or not the investments drive the urban development. The log of (FDI) (1998 and 2003) reflects capital inflows from outside (He et al., 2013). The size of the nonagricultural population (NP) (1998 and 2003) is used as a proxy for the size of the labor force since reliable employment data is not

Table 2-2 Independent variables

Category	Definition	Abbreviation
City Ranks	Municipalities (Dummy)	DM
	Vice Provincial Cities (Dummy)	DV
Economic and Demographic Drivers	Ln(Domestic Fixed Assets Investment)	FAI
	Ln(Foreign Direct Investment)	FDI
	Urbanization Rates	UB
	Nonagricultural Population (10,000)	NP
Local Administration	Road Area per Person (m^2)	RD
	Change of Numbers of National DZs	NDZC
	Ln(Fiscal Expenditure)	FE
Control Variables	Proportion of Second Sector (%)	SI
	Population Density ($1/km^2$)	PD

available for the entire sample period. Moreover, the nonagricultural population includes how many people are living in the urban area with nonagricultural household registration. An urbanization rate (nonagricultural population/total prefectural population) (UB) (1998 and 2003) is used to capture the demographic urbanization process in Chinese cities (Bai et al., 2011).

We employed the log of (Fiscal Expenditure) (FE) (1998 and 2003) to measure the decentralization process and the power of local administration of Chinese cities (Liao & Wei, 2012). Also, the literature mentioned that the increased use of land for transportation is an important driving force in construction land growth in China (Ding & Zhao, 2011; He et al., 2013). Road area per person (RD) is employed to represent the power of local governance, measured by m^2. The change in the number of national DZs (NDZC) (1998-2002 and 2003-2008) is incorporated into measurements of local state power and the benefits from central policymaking (Wei, 2012; Wei & Leung, 2005). We employed this variable because the national DZs have a more scientific and rigorous certification process from site selection to establishment. Moreover, national DZs serve to measure local economic development, as they are usually larger.

For the control variables, Proportion of Second Sector (SI) (1998 and 2003), measured as a percentage is used to capture the influence of manufacturing and industrial restructuring on the urban land expansion. The literature contends that higher population density represents the lower potential of construction land development (Fay & Opal, 2000; He, et al., 2013). Thus, we also used population density (PD) (1998 and 2003) ($1/km^2$) to control the availability of land.

Urban Land Expansion and Urban Administrative Hierarchy in China

Table 2-3 presents the expansion of construction land in Chinese cities at different levels. Urban expansion in Chinese cities accelerated between 2003 and 2008, with a growth rate of 7.74%, much higher than that of 1998-2002 (Table 2-3). Also, urban land expansion is more evident in cities above the prefectural level, and the difference is more conspicuous in the second study period. Within the cities above the prefectural level, the cities designated in the state plan experienced the fastest increase in urban land expansion between 1998 and 2003. However, since 2003, tremendous changes have occurred in the subprovincial capitals. The prefectural level cities have the lowest urban expansion rates, with a value of 3.98% in 1998-2002 and 6.02% in 2003-2008, compared to 7.10% and 18.00% in higher-level cities in the same periods (Table 2-3). The rates of land expansion in 19 higher-level cities, including subprovincial and direct-controlled municipalities, during these periods, are always greater than the average level of the whole country.

Lower administrative level cities tend to have a lower development rate. The annual average increase rates for direct-controlled municipalities, subprovincial cities, and

Table 2-3 Construction land expansion in urban administrative system of China

Administrative Level	1998-2002 Amount (km^2)	1998-2002 Growth rate (%)	2003-2008 Amount (km^2)	2003-2008 Growth rate (%)
Prefectural Level Cities	10822.20	3.98%	14494.00	6.02%
Cities above Prefectural Level	2700.40	7.10%	6205.31	18.00%
Direct-controlled municipality	1036.41	7.01%	1735.94	12.81%
Subprovincial Cities	1664.99	7.16%	4469.36	21.35%
Designated in State Plan	568.32	8.76%	1079.22	17.97%
Subprovincial Capitals	1095.68	6.55%	3390.14	22.72%
All Cities	14090.92	4.45%	21778.52	7.74%

Source: Land use change records from the MLR in China

prefectural cities from 2003 to 2008 are 12.81%, 21.35%, and 6.02%, respectively. Between 1998 and 2002, the change areas of the 19 highest-level cities accounted for nearly 20% of the total change in construction land area for all 227 cities. This number, for the period between 2003 and 2008, increased to 28%.

Figures 2-2 and 2-3 further confirm that differentiated magnitudes of urban land expansion, in different administrative levels, follow a relatively consistent pattern. Subprovincial cities had the highest urban land expansion rate during the study period, and the construction land areas of direct-controlled municipalities increased more and faster than that of the prefectural cities.

Tables 2-4 further shows details about urban land expansion in cities above the prefectural level. The total changes in construction land use of these 15 subprovincial cities were 1,629.3 km^2 in 1998-2002, and 3,090.57 km^2 for 2003-2008, while these numbers of four municipalities were 1036.41 km^2 and 1735.94 km^2, representatively. These cities have more extensive urban land expansion than prefectural level cities. The annual growth rate of the urban land area in the four direct-controlled municipalities, for both periods, is higher than 0.96%.

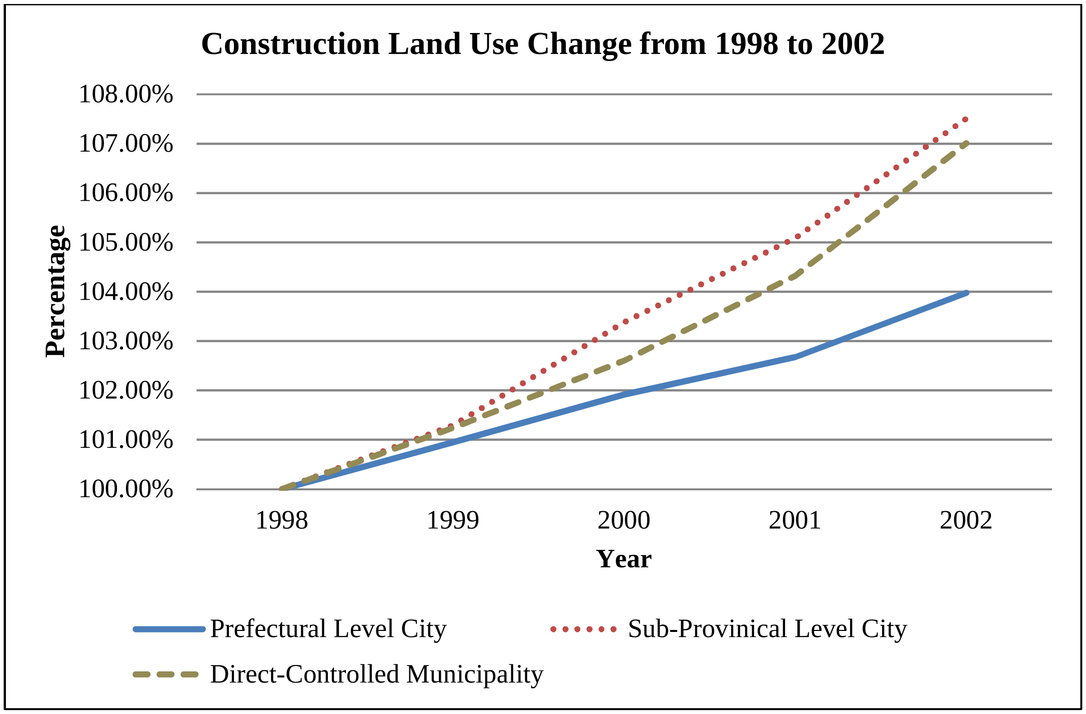

Figure 2-2 Construction land use change from 1998 to 2002 (1998=100%)
(Source: Land use change records from the MLR in China)

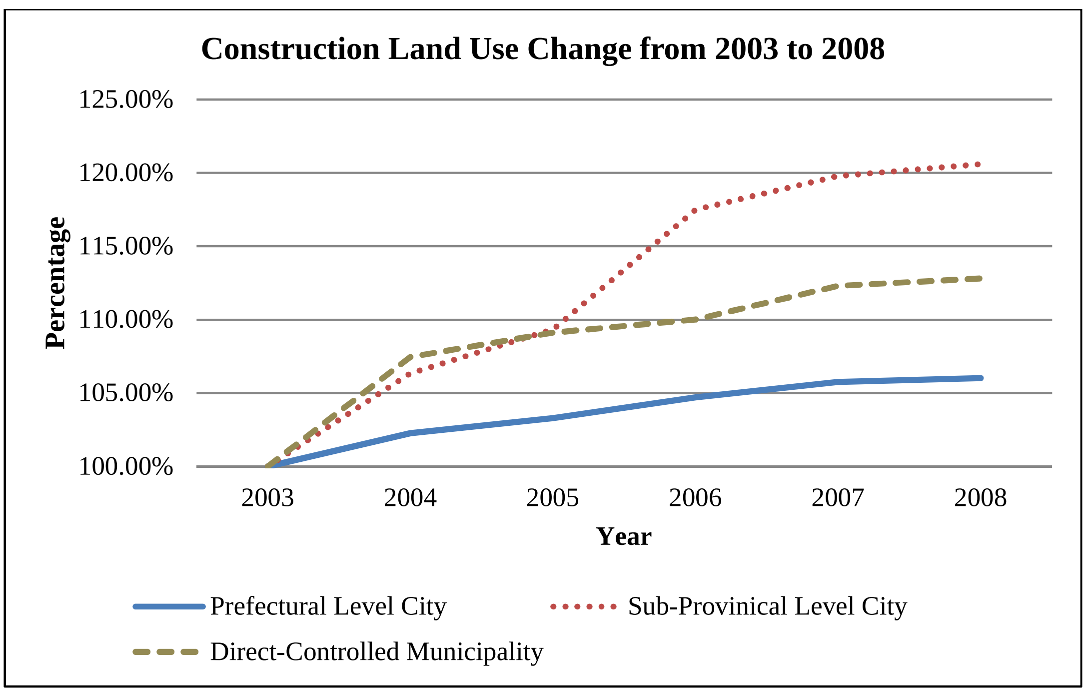

Figure 2-3 Construction land use change from 2003 to 2008 (2003=100%)
(Source: Land use change records from the MLR in China)

Table 2-4 Urban spatial expansions of Chinese cities above the prefectural level

City	Change of Construction Land 1998-2002 (km^2)	Annual Growth Rate 1998-2002 (%)	Change of Construction Land 2003-2008 (km^2)	Annual Growth Rate 2003-2008 (%)
Beijing	487.00	4.96%	313.61	2.50%
Shanghai	147.16	2.09%	214.47	2.33%
Tianjin	109.99	0.96%	530.36	4.02%
Chongqing	292.24	1.72%	677.5	3.11%
Changchun	95.79	1.26%	99.19	1.12%
Nanjing	153.39	3.23%	202.81	3.38%
Shenyang	46.66	0.71%	205.9	2.70%
Hangzhou	147.02	2.05%	281.49	3.85%
Jinan	72.07	1.80%	305.57	5.79%
Wuhan	130.58	3.07%	239.3	4.48%
Guangzhou	117.95	2.82%	322.64	5.77%
Chengdu	209.01	3.85%	209.46	2.84%
Xi'an	88.50	2.72%	144.99	3.28%
Ningbo	145.89	3.91%	319.33	6.41%
Xiamen	28.76	2.67%	125.16	8.57%
Qingdao	162.67	2.70%	315.07	4.21%
Shenzhen	180.08	7.81%	160.36	4.97%
Dalian	50.93	0.74%	159.3	1.89%

Source: Land use change records from the MLR in China

In other words, all the municipalities have experienced a tremendous construction land expansion in the past 11 years. As a political and educational center, Beijing experienced the largest expansion of construction land area between 1998 and 2002, and Chongqing had the highest increase of urban land from 2003 to 2008, which reflects a shift in focus of investment and policy support. Among the provincial capitals, Guangzhou, the southern economic center of China, exhibited the most significant urban spatial expansion, making this city the third largest city in China driven by the tremendous domestic and foreign investment (Lin et al., 2015). Nanjing and Hangzhou, located in the Yangtze River Delta, have the third and fourth highest expansion rates among these ten cities. The expansion in these cities could be explained by the establishment of university towns, development zones, and new CBDs (Ding & Zhao, 2011).

Urban land expansion differs across space and administrative rank. Based on the spatial distribution of urban construction land expansion during the periods of 1998-2002 and 2003-2008 (Figure 2-4 and 2-5), we could find that almost all the prefectural level cities witnessed an increase of construction land use. The increase rate of urban land during 2003-2008 is much higher than the period of 1998-2002, with the most significant growth during these 11 years occurring in the eastern coastal region and some western cities. In the eastern part, most construction land increases concentrate in the Yangtze River Delta and Pearl River Delta. The increase ratio of Yangtze River Delta from 1998-2002 is 7.18%, and this number increased to 18.09% for the period 2003-2008. The situation in Pearl River Delta is similar with Yangtze River Delta, from 1998 to 2002, this area had 12.28% construction land increase, and for the period during 2003 to 2008, this number is 15.85%. In the western part, we also found that Ordos had experienced 28.99 % growths in urban areas during 2003 to 2008, which is in stark contrast to many prefectural cities, for instance, Changsha, the capital of Hunan province, had 15.45% growths in construction land from 2003 to 2008. Two major city-regions in the eastern China, including Yangtze River Delta and Pearl River Delta, witnessed the dramatic urban land growth (Figure 2-6). We could found that Shanghai, Nanjing, Shenzhen, Guangzhou, Ningbo, and Hangzhou have larger construction land expansion than other prefectural level cities (Seto et al., 2002).

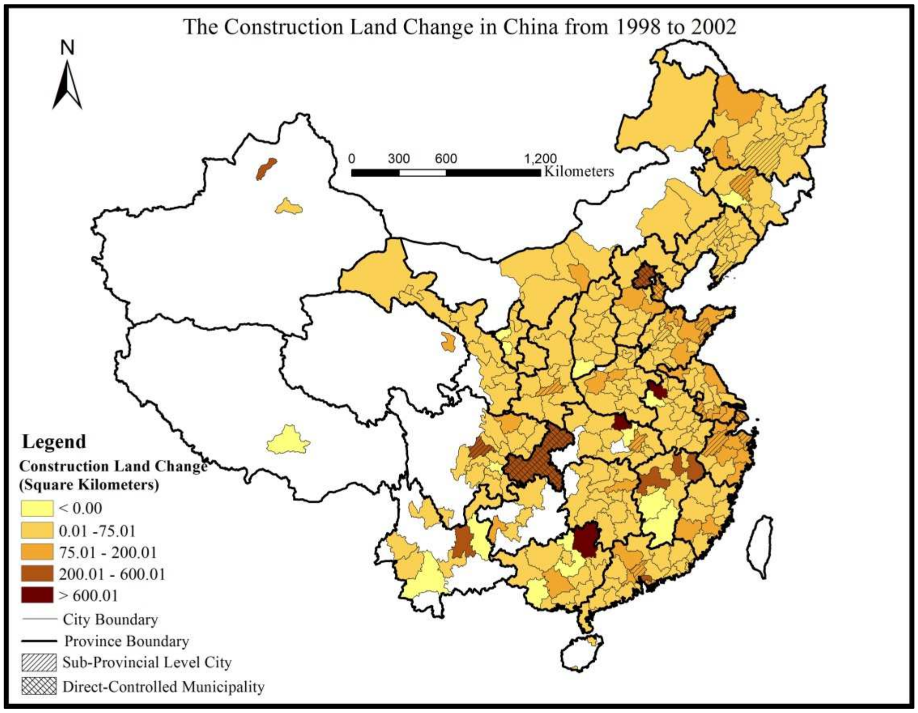

Figure 2-4 Construction land change in cities above prefectural level, 1998-2002
(Source: Land use change records from the MLR in China)

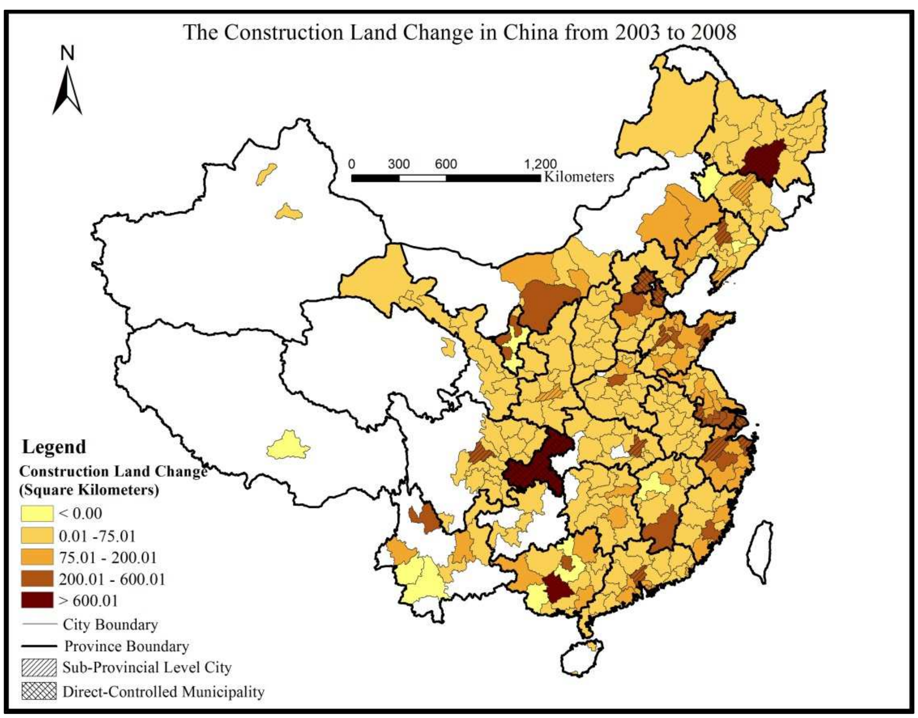

Figure 2-5 Construction land change in cities above prefectural level, 2003-2008
(Source: Land use change records from the MLR in China)

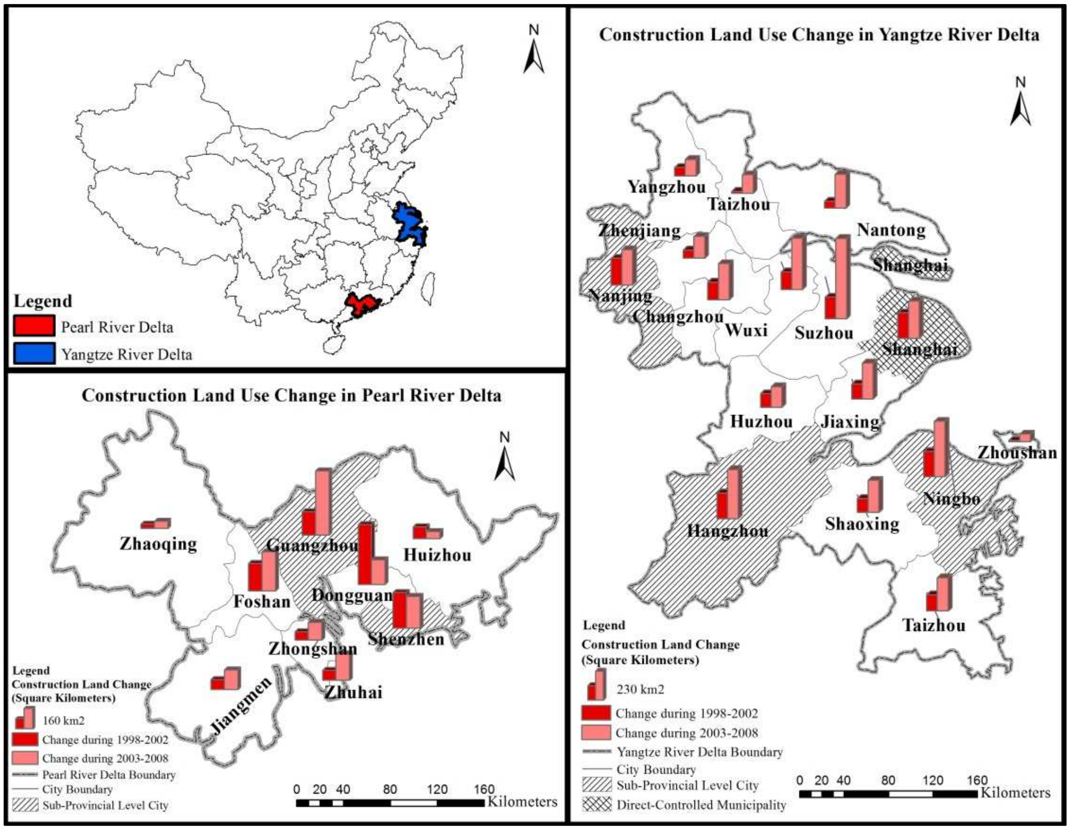

Figure 2-6 Construction land change in Pearl River Delta and Yangtze River Delta (Source: Land use change records from the MLR in China)

Does City Rank Really Matter? Evidence From Panel and OLS Regressions

The previous analysis confirms the association between a city's rank and the magnitude of urban expansion. We further employ panel regression and pooled regression models to test the hypothesis in a multivariate environment. Table 2-5 represents the correlation analyses of both periods. All the coefficients in these tables are smaller than 0.75, which imply that there is no multicollinearity problem in these models. It is not surprising that urban land expansion and the dummy variables of municipalities and vice provincial cities (DM, DV) are strongly correlated, given the fact that higher-level cities have more construction land increase. The variables FAI, FDI, NP, and NDZC, are also significantly related to the urban land expansion, with all the coefficients greater than 0.5.

Table 2-5 Correlation coefficients among dependent and independent variables

1998-2002												
	Expansion	DM	DV	FAI	FDI	NP	UB	FE	RD	NDZC	SI	PD
Expansion	1											
DM	0.49***	1										
DV	0.28***	-0.04	1									
FAI	0.62***	0.41***	0.46***	1								
FDI	0.45***	0.28***	0.38***	0.64***	1							
NP	0.57***	0.74***	0.38***	0.67***	0.48***	1						
UB	0.15***	0.19**	0.28***	0.23***	0.19**	0.34***	1					
FE	0.55***	0.48***	0.57***	0.73***	0.64***	0.71***	0.49***	1				
RD	0.13*	-0.02	0.06	0.27***	0.34***	-0.02	0.28***	0.23***	1			
NDZC	0.59***	0.35***	0.32***	0.57***	0.51***	0.55***	0.30***	0.64***	0.16**	1		
SI	0.06	0.02	0.074	0.31***	0.14***	0.08	0.19***	0.22***	0.22***	0.16**	1	
PD	0.16***	0.23***	0.13***	0.35***	0.38	0.31***	0.08	0.38***	0.12*	0.19**	0.16**	1

2003-2008												
	Expansion	DM	DV	FAI	FDI	NP	UB	FE	RD	NDZC	SI	PD
Expansion	1											
DM	0.51***	1										
DV	0.39***	-0.03	1									
FAI	0.74***	0.35***	0.44***	1***								
FDI	0.59***	0.28***	0.42***	0.73***	1							
NP	0.62***	0.73***	0.38***	0.68***	0.53***	1						
UB	0.27***	0.19**	0.29***	0.31***	0.43***	0.37***	1					
FE	0.66***	0.42***	0.512***	0.74***	0.72***	0.64***	0.58***	1				
RD	0.26***	0.03	0.19***	0.42***	0.41***	0.1*	0.33***	0.37***	1			
NDZC	0.74***	0.41***	0.54***	0.67***	0.56***	0.60***	0.34***	0.67***	0.23***	1		
SI	0.22***	-0.01	0.08	0.41	0.28***	0.07	0.34***	0.30***	0.42***	0.17***	1	
PD	0.28***	0.24***	0.20***	0.44**	0.45***	0.42***	0.23***	0.47***	0.21**	0.30***	0.19***	1

*** p value < 0.01; ** p value < 0.05; * p value < 0.10

Moreover, based on the Hausman test, the random effect model is preferred in the panel regression.

Table 2-6 reports model outputs for estimation of parameters of local state, economic and population variables for panel data regression and ordinary least squares (OLS) in two periods, 1998-2002 and 2003-2008. As shown in Table 2-6, the variables of municipalities are highly significant and strongly positive with the coefficient of 164.125 in Model 1 (panel regression), 136.418 in Model 2 (OLS regression) and 206.834 in Model 3 (OLS regression), respectively. It indicates that municipalities lead to a more extreme land expansion in urban China. Moreover, the parameters of DV in all the three models are also significantly positive. It should be noted that this finding is derived from a full model when other factors such as economic and population are controlled.

In addition to city ranks, in Model 2, the significantly positive determinants of urban growth in China include domestic fixed assets investment (FAI), foreign direct investment (FDI), nonagricultural population (NP) and change numbers of national development zones (NDZC). The larger nonagricultural population leads to more urban land expansion, while the urbanization rate has a negative influence on land expansion in Chinese cities during 1998-2002 when larger cities' urban growth was still under strict control (Bai et al., 2011; Zhou & Ma, 2000, 2003).

In Model 3, the coefficient FDI is significantly positive, indicating that capital flows from outside have been more influential in urban land expansion in Chinese cities. Regarding control variables, population density (PD) has a negative impact on urban land expansion, representing that urban land expansion is conditioned upon the availability of a city's land.

Table 2-6 Result of panel and OLS regressions

Variables	Full Name	Model 1 Panel Model	Model 2 1998-2002	Model 3 2003-2008
City Ranks				
DM	Municipalities	164.125***	136.418***	206.834***
DV	Subprovincial Cities	13.824*	19.051*	9.759*
Economic and Demographic Drivers				
FAI	Ln(Domestic Fixed Assets Investment)	35.556***	24.824**	43.008***
FDI	Ln(Foreign Direct Investment)	1.698*	0.896	2.751*
NP	Ln(Nonagricultural Population)	0.074*	0.029	0.123*
UB	Urbanization Rates	-9.821*	-28.312**	-8.611
Local Administration				
FE	Ln(Fiscal Expenditure)	-2.434	-2.194	-2.442
RD	Road Area per Person	0.253	0.437	0.447
NDZC	Change in the Number of National DZs	65.428***	38.794***	88.446***
Control Variables				
SI	Proportion of Second Sector	-0.354	-0.437*	-0.023
PD	Population Density	-0.017***	-0.015*	-0.023***
Intercept		-389.056***	-236.178***	-505.855***
R^2		0.651	0.537	0.711
Observations		501	227	274

Note: (Unbalanced Panel) *** p value < 0.01; ** p value < 0.05; * p value < 0.10

The Urban Hierarchy of Land Expansion Mechanisms

The proceeding section analyzes how different dynamics of urban land expansion are sensitive to different city ranks or the hierarchical structure of the Chinese urban administrative system. By applying spatial regime models, we can further produce, in a more rigorous multivariant environment, two sets of comparable coefficients that are dedicated to each level of cities. As shown in Table 2-7, coefficients of FDI, FAI, NDZC, and fiscal expenditure (FE) for two regimes have different values. It implies that urban land expansion mechanisms of Chinese cities are sensitive to a city's rank. For different periods, different components in the urban hierarchical system have dissimilar functions on urban growth. For instance, in the results of higher-level cities, FDI apparently have a stronger influence on urban land expansion (Table 2-7), despite the fact that its influence on urban land expansion is marginally significant in low-level cities since 2003. This result confirms that the larger cities with better infrastructure systems have better success in drawing FDI (Ke et al., 2014) and implies that the power of globalization is allocated by the hierarchical system in China. By contrast, domestic investment and local fiscal expenditure are one of the most significant indicators to investigate the mechanism of urban land expansion in China. Development of national DZs is evidently a positive impetus for urban expansion in China. Notably, the effect of DZs is more intensive for urban land expansion in higher-level cities than prefectural cities. This result can be interpreted by the fact that the administrative powers of approving national DZs are concentrated in the large cities. Interestingly, the second study period (2003-2008) witnessed an increased impact of DZ on land expansion in lower level cities. It is consistent with the spread of development zone fever to inland and smaller cities.

Table 2-7 Result of spatial regime regression

Variables	Full Name	1998-2002		2003-2008	
		Higher Level	Prefectural Level	Higher Level	Prefectural Level
Economic and Demographic Drivers					
FAI	Ln(Domestic Fixed Assets Investment)	117.311***	22.57***	1.631*	44.780***
FDI	Ln(Foreign Direct Investment)	36.382*	1.957	61.056*	1.276*
UB	Urbanization Rates	-109.501*	-21.981*	11.200	3.329
NP	Ln(Nonagricultural Population)	0.181*	0.0087	0.372***	0.144**
Local Administration					
FE	Ln(Fiscal Expenditure)	-86.751*	0.928*	-12.454	1.308*
RD	Road Area per Person	-0.6415*	0.546	-1.164	0.334
NDZC	Change in the Number of National DZs	187.219***	24.710***	171.038***	78.522***
Control Variables					
SI	Proportion of Second Sector	11.961**	0.393*	6.601**	-0.208
PD	Population Density (1/km^2)	0.051*	-0.012*	-0.182***	-0.0108*
Intercept		-251.110**		-541.606***	
R^2		0.616		0.754	
Observations		227		274	

Note: *** p value < 0.01; ** p value < 0.05; * p value < 0.10

Different from the results of OLS regression that does not consider the hierarchy of land expansion mechanisms, results of spatial regime model demonstrate a strong relationship between SI and urban land expansion, especially in the higher-level cities.

Conclusion

In China, the land is being rapidly converted from rural uses to urban uses. The land is needed to fuel economic growth, and it has become an important instrument of local states when promoting economic growth. In the case of China, the magnitude of urban land expansion is not purely driven by capital inflows or rural-urban migration. Local governments have been playing a proactive role in this process (Wei, 2012). As argued by Friedmann (2006), the neoliberal interpretation of land development in China, which tries purely to understand the mechanisms of urban land expansion in China from an economic perspective, is obviously simplistic and deterministic since it ignores some of the fundamental social and political conditions of China. Contrary to previous literature, this paper quantifies the association between urban administrative hierarchy and urban land expansion in the context of the Chinese economic transition while probing the hierarchy of land expansion mechanisms.

We found that the magnitude of urban expansion coincides with a city's administrative rank, and the relationship between urban land expansion, the economic transitions, the growth of the economy and population are sensitive to a city's rank. First, urban expansion in China is driven by mixed powers including economic transition, local state effort, economic growth and population growth. Second, high-level cities' urban expansion in China has been more likely to be associated with FDI, characterizing the significant impact of economic globalization on urban expansion in these cities (Wei, 2012). By contrast, the establishment of DZs and fixed assets investments are closely related to urban expansion for all level cities, echoing the notion of development zone fever and investment-driven expansion model in China. Therefore, our model results prove the self-evident relationship between urban hierarchies and the land expansion in Chinese cities, which that have been presented in previous qualitative studies (Lin & Ho, 2005; Ma, 2002). Moreover, by demonstrating the urban hierarchy of different well-documented indicators of urban land expansion, this paper advances the understanding of the mechanisms of urban expansion in Chinese cities. Above all, we believe that the Chinese urban hierarchy system deserves more attention from those who care about the urbanization process in China. Such attention will further the understanding of a theoretical framework regarding land expansion and enlighten the policy debates over better land use in China.

From a policy perspective, as land use decision making grows into the central issues of Chinese cities, the hierarchy of Chinese cities tends to reinforce the inequalities in land development in China and cause more tensions between different levels of cities. We suggest that reforming local land property rights regimes, changing constraint structures of local governments in the hierarchical system, and better design of land use and DZs' development policies beyond the rank-based system would be next focuses for reforming China's political system and for purposes of sustainable urbanization in the future.

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CHAPTER 3

CONSTRUCTION LAND USE RESTRUCTURING IN URBAN CHINA: A COMBINATION OF SHIFT-SHARE AND SPATIAL ECONOMETRICS

Abstract

After examining the role of the urban administrative system in the land development of urban China, this chapter further investigates the spatial-temporal pattern and dynamics of structural change in construction land related to economic transition, relying on the official industrial, transportation, and urban land data from 1998 to 2008 in China. We introduce the shift-share analysis to capture regional land use change, and find that the agglomeration phenomenon of proportional increases and regional construction land increase expanded from coastal regions to some key interior cities during 1998-2008. By employing spatial lag and geographically weighted regressions to investigate varying relationships between spatial effects, economic transition, and regional land use change, we find that the determinants of regional construction land development in China are sensitive to land use types and location. The urbanization is the major driving force for urban land expansion, while the industrial adjustment and globalization play the most significant roles in the development of the industrial land use in East China. The decentralization is the most important determinant of transportation land change in South China.

Introduction

China's economic reform and growth have brought the greatest urbanization process in the world, which also has led to the significant land use change in urban China (Wei, 2012; Wei & Ye, 2014). The most significant characteristics of this structural change are the increase of construction land and the shrinkage of agriculture land (He, Huang, & Wang, 2013). Based on the official data from Ministry of Land and Resource, during the period from 2004 to 2008, the construction land in China increased by 12,600 km^2, while the arable land declined by 7,510 km^2.

Scholars have concluded that the construction land use change in China is driven by the transition from planned economy to market economy (Li, Wei, & Huang, 2014; Li, Wei, Liao, & Huang, 2015; Lin, 2007; Lin & Ho, 2005). Moreover, this economic transition is generated as the triple-process: marketization, globalization and decentralization (Wei, 2001, 2015). The subcategories of construction land use, such as transportation land, industrial land, and urban land, also have attracted scholarly attentions (He et al., 2013; Huang, Wei, He, & Li, 2015). Geographers have found that the determinants of different type of land use change are not identical. For instance, for industrial land expansion, all of the triple processes have significantly positive influences, while only marketization has a significant influence on urban land (Huang et al., 2015). Therefore, a detailed and expanded framework is needed more fully to explain the mechanisms of land conversion in China. Furthermore, in previous studies, the measurements of urban expansion are dominated by the absolute changes of construction land and built-up areas, which cannot highlight the regional advantage without considering the structural influences and the effects of national land development (Deng, Huang, Rozelle, & Uchida, 2008; Seto & Kaufmann, 2003; Yeh & Li, 1998).

A number of factors can affect land use change: trade between prefectures, technology and knowledge diffusion, and, more generally, regional spillovers, that lead to geographically dependent urban expansion for each prefecture. The role of spatial effects is important for evaluating urban expansion processes in China, by using the appropriate spatial statistics and econometric methods. However, in the previous literature about urban growth modeling, the spatial effect and geographical locations are neglected (He et al., 2013; Li et al., 2015). Thus, this study comprehensively investigates the regional disparities of industrial, transportation and urban land use change in China. We also highlight the dynamics of regional changes of these kinds of land use in the context of the economic reform of China, which also consider the effects of geographic locations on urban land use change.

The remainder of the chapter is organized as follows: after the introduction, we briefly review the literature on land use change and its dynamics in China. This is followed by data and methodology, such as the samples of 283 prefectural level cities over two periods, as well as the spatial econometric used in this study. In the next section, we present regional disparities of regional land use change. In the next section, the shift-share and dynamics analysis results are offered. In the last section, a brief conclusion reflects on land use change and its significance for research in urbanization in China.

Literature Review

Global Studies in Urban Land

Earlier studies of urban land mainly focused on the spatial structure of urban land use, which could be widely divided into two groups: evolution of urban space and description of the urban structure. Studies of the evolution of urban spatial structure, which is the arrangement of land use in urban areas and the combination of distribution of different functional zones in the city, have been highly associated with the process of industrialization and advances in transport and communication (Anas, Arnott, & Small, 1998). Major early theoretical contributions on this line were made by the Chicago School, with the development of traditional models of urban spatial structure, including the concentric zone model (Burgess, 1924), the sector model (Hoyt, 1939), and the multiple nuclei model (Harris & Ullman, 1945). The post-World War II era from the 1950s to 1960s witnessed the rise of neoclassical economics in social sciences and geography, including the use of factorial ecology in social analysis, the understanding of the urban land value and its linkage with the urban form through the bid-rent theory (Alonso, 1964; Rees, 1971). The development of alternative thinking marked the 1970s and 1980s, including neo-Marxist urban theories, behavioral approaches, and the Third World perspective (Harvey, 1985).

Unlike the first group that has been assessed and developed based on the basic land-use data, the second trend has been more likely to employ different measurements, such as urban population and employment, to capture and describe the urban structure, based on the mathematical description of people’s spatial activities. The methods as point pattern analysis and fractal dimension (Batty & Longley, 1994) were raised in the 1980s and 1990s to define urban spatial structure quantitatively. Recently, scholars have sought to describe the regularities of urban space based on the spatial concentration of modern human activities, such as traffic flow, imbalance of housing and job, mobile communication frequency, and even Wi-Fi access (Kwan, 2007).

With the intensification of globalization and urbanization in the late 1980s, scholars have turned their attention to the underlying patterns and dynamics of urban expansion, mostly in developing countries (Turner, Lambin, & Reenberg, 2007). Theoretically, scholars have found that foreign capitals have become a major force driven urban land development (Wei, Yuan, & Liao, 2013). Technologically, a noticeable change has been the emerging application of geographic information science (GIS) and remote sensing on land use studies, especially in urban expansion and land use change (Deng, Huang, Rozelle, & Uchida, 2006; Metres, Schneider, Sulla-Menashe, & Tan, 2015). On the other hand, various modeling approaches such as agent-based modeling and spatial regressions have been widely applied to analyze the underlying determinants of the conversion of land use (Luo & Wei, 2009). Results from these models suggest that the factors, such as distance to transportation and central business districts (CBDs), development of mega-projects, development zones and infrastructures, and the increasing value of the real estate in the suburban area, are primarily determining urban land expansion (Schneider & Mertes, 2014). Besides these fundamental patterns and determinants of urban land expansion, scholars have also investigated the process and agents of urban land use change and issues of perceptions, power, and motivations (Ganderton, 1994; Gore & Nicholson, 1991; Healey & Barrett, 1990).

Literature in China

Earlier studies focusing on China have been more concerned with the patterns of land use structural change. They have found that the primary pattern is the conversion from agriculture land use to nonagricultural land use (Deng, Lin, Zhan, & He, 2010; Ho & Lin, 2004). From 1983 to 1996, approximately 80% of increase of construction land was converted from the arable land. Moreover, during the period between 1996 and 2008, the construction land increased by 13.55%, while the transportation land use increased by 46.65%, and arable land decreased by 6.4% (Wang, Chen, Shao, Zhang, & Cao, 2012). Geographically, scholars have also found that there are some segregations and gaps in the construction land increase between regions. The construction land use increase is descending from coastal to the inland area, from high-level rank cities to prefectural cities, and spreading from metropolitans to small towns (Li et al., 2015; Schneider & Mertes, 2014; Zhang, Zhou, Chen, & Ma, 2011).

Besides the characteristics of dramatic urban expansion in China, the underlying mechanisms of these changes also draw plenty of attentions from scholars (Wei, 2012, 2015; Wu & Yeh, 1999). The institutional school believes that the construction land increase is driven by the economic reform since it introduces new elements into contemporary China, and the urban development is following the principle of the economic system. Moreover, the triple-process of economic transitions in China—that is marketization, globalization, and decentralization—has changed in significant ways how China uses its land (Wei, 2001). To examine how the economic transition affects urban expansion in China, scholars have demonstrated the changes of mechanisms in urban growth and have found that central planning and market forces are the two major impetuses. Since the 1990s, by adding a market element into the real estate development, central and local governments have changed the trajectory of urban land development in China, which reflects that decentralization and marketization are the prominent underlying driving forces of China's construction land expansion (Wei, 2012; Wu & Yeh, 1997, 1999).

In addition to the institutional school, there have also been plenty of scholars using an urban growth model to examine the economic factors with multiscales. They have found that tremendous urbanization and economic growths and adjustments are the major driving forces, and the detailed determinants of this change differ across space and scale (Deng et al., 2006, 2008; Tan, Beckmann, Berg, & Qu, 2009; Wang et al., 2012). Nationally, based on the classification result of large-scale remote sensing data, Deng et al. (2006, 2008) concluded that the main driving forces of urban land development are urbanization and adjustment of economic structure. Other geographers, such as Lin and Ho (2005) also stated that the industrialization process in a rural area and large numbers of migration from a rural area to urban area are primary factors influencing construction land expansion in urban China. Some other research found that the increasing of tertiary industry and average salary are important impetuses after urban growth in China (Ding & Lichtenberg, 2011).

For the regional level, the scholars have concluded that the economic growth is the most significant driving force of construction land expansion in Yangtze River Delta (Tian & Ma, 2011). Furthermore, the research about Pearl River Delta has pointed out other detailed factors of construction land expansion, such as foreign direct investment (FDI), fixed asset investment and arable land value. Tan, Li, Xie, and Lu (2005) specified that there are some extra factors such as household registration system and land use policy, which led the rapid growth of built-up areas of Beijing and Tianjin urban agglomeration area. In individual city scale, geographers have found that the income gap between rural and urban residents are extra driving forces of urban sprawl in Beijing (Deng & Huang, 2004; Xie, Fang, Lin, Gong, & Qiao, 2007). The average residential area for each person and the special relationship between rural and urban area are the unique factors for Shanghai (Han, Hayashi, & Cao, 2009; Li et al., 2014; Li & Wu, 2006). Moreover, geographers have pointed out that the development of transportation system is one of the most superior driving forces of construction land expansion in Guangzhou (Fan, Wang, Qiu, & Wang, 2009; Ma & Xu, 2010).

Besides the construction land use, the expansion of some subcategories of construction land also has attracted scholarly attention, for example, the industrial land use. According to the supply data from the China's Yearbook of Land Resource, from 2004 to 2010, Chinese government provided 1,070 km^2 for industrial land. The scholars have achieved that the expansion of the industrial land use is driven by the low-priced transferring of land use right, which is highly associated with the globalization and decentralization, and based on the establishment of industrial development zones. Since the manufacturing is more likely be to provide a stable and long-term tax income, the local state relies on the development of industry to attract investment, to create job opportunities and gather population (Braustein & Epstein, 2002; Tu, Yu, & Ruan, 2014). In addition to the state-oriented pattern, the industrialization of village enterprises is another factor of industrial land expansion. Especially in Guangdong, the development of land stock cooperative system drastically increases the proportion of industrial land use.

Different from the industrial land use, the studies focusing on the transportation land use has been more concerned with the relationship between transportation system and overall urban structure (Badoe & Miller, 2000; Iacono, Levinson, & El-Geneidy, 2008). More studies are needed on the mechanisms of transportation land use from an economic and geographical perspective. Moreover, since most studies use the construction land use increase representing the urban land expansion (He et al., 2013; Li et al., 2015), the specific urban area use in China have been ignored since the 1990s. Therefore, because of missing the analysis of these two subcategories, the structural changes and advantages of construction land use in China are still uncovered by the existing literature.

Overall, although there are plenty of empirical studies examining the mechanism of construction land increase in China within different study periods, geographical scale and area of interest, there are still three academic areas that need further research efforts. First, the measure of land use change is monotonic, which could not cover the influence of the structural advantage and national development for each prefecture. Second, these urban growth models conspicuously neglect the role of spatial effects. Third, the mechanisms of subcategories of construction land use change in the context of economic transitions are uncovered.

Data and Methodology

Data Collection

In this study, the source of land use data was the records of Ministry of Land and Resources (MLR), which document land conversion between urban and nonurban areas in detail from 1998 to 2008. This dataset was the only official dataset of land use change in China (He et al., 2013). It is worth to point out that this dataset was divided into two periods, 1998-2002 and 2003-2008 since the MLR changed the statistical measures between 2002 and 2003. The socioeconomic data were collected from the China Urban Construction Statistical Yearbook (CSSB[a], 1998-2010) and China Urban Statistical Yearbook (CSSB[b], 1998-2012). To correct the inflation of all the monetary values to the constant 2000 level, we employed the fixed price consumer price index reported by China's National Bureau of Statistics.

Methods

The method applied in this study is an integration of the shift-share analysis and the spatial econometrics. To consider the influence of structural advantages and the effects of national land development on the land use change for each prefecture, we employed the shift-share analysis to calculate the regional land use change for each prefecture. To investigate the different mechanisms of the construction land use change in China, the spatial lag regression and geographically weighted regression (GWR) were employed to capture the relationships between globalization, marketization, decentralization, urbanization, and the regional subcategories land use changes in all 283 Chinese prefectures.

Some studies have focused on analyzing changes in employment and productivity as determinants of economic growth using shift-share analysis or a related methodology (Wadley & Smith, 2003). We introduced the shift-share analysis into land use studies to evaluate the magnitude of regional land use change. In Eq. 3-1, regional and national land uses are represented by e and E, respectively. The subscript i represents land use change in a specific subcategory, such as industrial, urban and transportation. The superscripts t and $t+n$ represent the two years, where year $t+n$ occurs n years after year *t*. The regional change in subcategory of land use change between the two years, or $e_i^{t+n} - e_i^t$, is defined as the sum of the three effects: national growth effect (or national share, *NS*), industry mix effect (*IM*), and local share effect (or regional share, *RS*). The detailed equation is:

$$e_i^{t+n} - e_i^t = NS_i + IM_i + RS_i \quad \text{(Eq. 3-1)}$$

Where the three effects are defined as:

$$NS_i = e_i^t[E^{t+n}/E^t - 1]$$

$$IM_i = e_i^t[E_i^{t+n}/E_i^t - E^{t+n}/E^t]$$

$$RS_i = e_i^t[e_i^{t+n}/e_i^t - E_i^{t+n}/E_i^t]$$

To identify the mechanisms of regional land use change in Chinese cities, we employed the regressions to estimate the parameter of each explanatory variable. However, ordinary least squares (OLS) cannot avoid the influence from spatial autocorrelation, which will create problems for estimation, assuming the model is correctly specified. In this study, the results of Moran's I imply that the spatial autocorrelation exists in the dependent variables, and the Lagrange-multiplier (LM) test for autocorrelation reveals that there is spatial autocorrelation in the residuals. To solve the problems of estimating the spatially y model, we employed the spatially lagged model in matrix algebra. The spatial lag regression is used to capture the general driving force and dynamics of this construction land change and the neighborhood effect of each land use type. Replicating the notation in Anselin (2013), the spatially lagged *y* model can be expressed as (Eq. 3-2):

$$Y = \rho W y + X\beta + \epsilon \qquad \epsilon \sim N(0, \sigma^2 I) \qquad \text{(Eq. 3-2)}$$

In this equation, Y is the regional land use change, X is the explanatory variable, such as the urbanization, economic transitions, β represents the parameter of the explanatory variable. Wy is the spatial lag operator, a weighted average of random variables at neighboring locations. In which, W is 283×283 spatial weights matrix of these Chinese cities, y is a 283×1 vector of observations on the random variable, ϵ is zero mean error terms with common variance σ^2, and ρ is autoregressive and moving average parameter.

A global regression model only represents the broad spatial trends and may mask significant local variation. To model the spatially heterogeneous processes in urban land expansion and its local variations of the underlying dynamics, we applied the geographically weighted regression (GWR) to measure the complex local variation of regression parameters. In its most basic form, the GWR model takes the following equation (Li et al., 2014) (Eq. 3-3):

$$Y_i = C_i + \sum_k \beta_{ki} X_{ki} + \varepsilon_i \qquad \text{(Eq. 3-3)}$$

In which Y_i is land-use change to be regressed, C_i is constant, β_{ki} is the parameter for individual explanatory variable X_{ki} *(k=1, 2, 3… n)*, ε_i is the error term.

Variables

Table 3-1 demonstrates the descriptive details of both the dependent variable and independent variables in this study. Since we viewed the regional share of urban land use change as the regional land development, the dependent variable in this study is the regional share of three specific land use types, urban, industrial, and transportation in

Table 3-1 Variables

Response Variables	Description	
Land Use Change	Regional share of urban land (km^2)	
	Regional share of industrial land (km^2)	
	Regional share of transportation land (km^2)	
Predictor Variables	**Description**	**Abbreviation**
Urbanization	Change of urbanization rates	*UB*
Industrial Restructuring	Change of proportion of the second sector	*SI*
Decentralization	Average of (Prefectural fiscal expenditure/Provincial fiscal expenditure) (10,000 RMB)	*OUTP*
Globalization	Change of (FDI/GDP)	*FDI*
Marketization	Number of PE employee/Number of SOE employee	*NSOE*
Accessibility	Change of average road area (m^2)	*ROAD*
	Having airport (Dummy)	*AIRPORT*
Control Variables	Ln(Change of GDP) (10,000 RMB)	*GDP*
	Change of Population Density ($1/km^2$)	*PDC*

Chinese cities. Among these variables, the land use of the urban area is a combination of the land use for cities and designated towns. The data of industrial land use are the area for the stand-alone industrial land use, which almost cover the main body of industrial land use in China (Huang et al., 2015).

In the context of economic transition in China, based on the literature review, we conducted six types of independent variables, including industrial restructuring, urbanization, decentralization, globalization, marketization, and accessibility. Changing urbanization rates for two periods, 1998-2002 and 2003-2009 were used to capture the process of demographic urbanization of Chinese cities (Bai et al., 2011). Specifically, we expected a significantly positive influence on urban land use change. We applied the change of proportion of the second sector to capture the industrial restructuring process in Chinese cities. A strong positive relationship between industrial restructuring and regional industrial land use change was expected in the regressions (He et al., 2013). The average of the proportion of prefectural fiscal expenditure and provincial fiscal expenditure was reported in 10,000 RMB and was used as a proxy of the decentralization process of China (Li et al., 2015). We used the change of ratio between FDI and GDP to measure the globalization process. The unit of FDI was transferred from dollar to RMB to get the real ratio, based on the exchange rate of each year. We expected that a significant positive influence on the regional industrial land use change (Li et al., 2015). Marketization was estimated by the ratio between a number of private enterprise (PE) employees and numbers of state-owned enterprise (SOE) employees (Liao & Wei, 2012). To develop the specific indicators to capture the mechanisms of transportation land expansion, we added the accessibility variables in the models.

The change of average road area is reported in m^2 and is used to capture the inside accessibility of the city. A dummy variable measured whether the city has an airport, which has been proved as a significant approach to increase the warehousing land use. 0 means there was no airport in the city and 1 means the city at least had one airport. We expected that this variable was a significantly positive associated with regional transportation land change.

To control the economic growth and sustainability of land, we used a change of gross domestic production and population density as the control variables (Ding & Lichtenberg, 2011). Since economic growth was viewed as the major driving force of the construction land increase in Chinese cities, we assumed that there should be a positive relationship between land use changes and the increase of GDP. Moreover, in the high population density areas, the potential land that can be transferred to construction land is relatively insignificant, so we expected the negative coefficient in the model of population density change.

Construction Land Use Change in China

The amount of construction land in China increased during 1998 to 2008 (Table 3-2). In the first period, the average rate of increase in construction land was 4.36%, and this rate enlarged to 7.98% for the next period. The development of construction land in China has accelerated since 2003. For all the subcategories construction land use, the rate of increase between 2003 and 2008 was much higher than the first five years. For urban land use change, the land used for cities and designated towns had a significant increase with the 31.31% and 22.91%, respectively, during 2003 to 2008. Since there were more and more labor forces that transfer from rural to urban, the increase of rural residential land was comparatively slow. On the other hand, the stand-alone industrial land use and transportation land use also experienced a tremendous increase during these periods.

Figure 3-1 gives the structure change of urban, industrial, transportation categories during two study periods. The construction land use change in China differed across different subcategories. All three subcategories of construction land use had the similar trend in structure change. The ratios of structure change in these subcategories land use change between 2003 and 2008 were higher than the ratio between 1998 and 2002. Industrial land use still was the major proportion of construction land, and the ratio of industrial land use had the largest increase, from 8.2% to 12.5%. Although there were similar increasing trajectories for all land use types, a further investigation of the underlying dynamics and mechanisms was needed.

Table 3-2 Structural change of construction land in China from 1998 to 2008

Land Use Categories	1998-2002 Rate (%)	1998-2002 Amount (1000 km^2)	2003-2008 Rate (%)	2003-2008 Amount (1000 km^2)
Construction Land	4.14	10.28	7.98	20.66
I. Settlements and Industrial	3.58	7.23	7.88	16.49
II. City	7.63	1.08	31.31	4.77
II. Designated Town	12.76	1.56	22.91	3.19
II. Rural Settlement	0.69	0.10	0.41	0.62
II. Stand-alone Industrial	13.68	3.55	26.84	7.91
I. Transportation	14.87	2.32	19.15	3.47
I. Water Conservancy	2.40	0.73	2.22	0.69

Sources: *The records of Ministry of Land and Resources (1998-2008)*

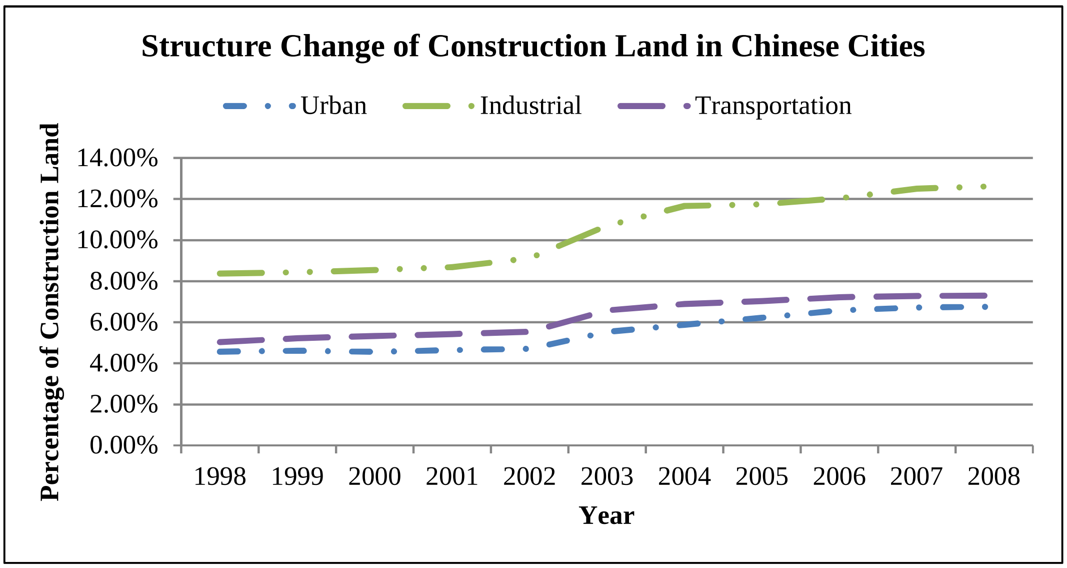
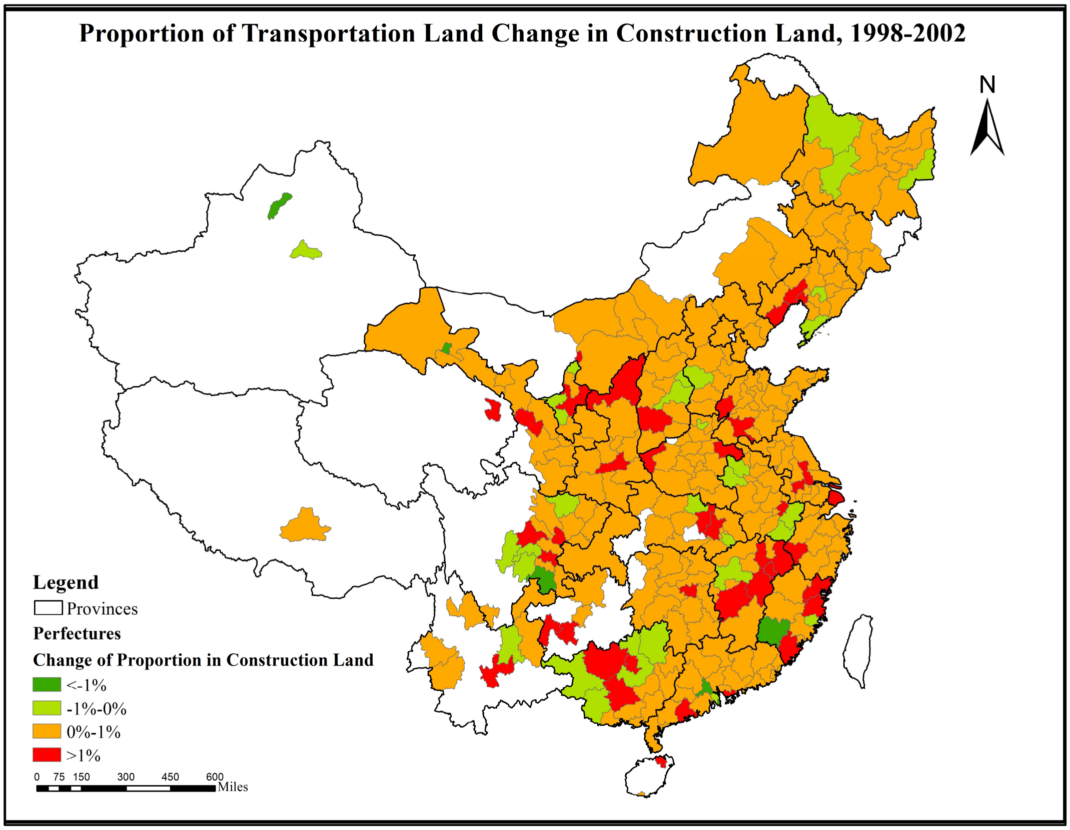


Figure 3-1 Structural change of construction land in Chinese cities

The spatial patterns of structure change of construction land vary across two different periods and three subcategories. Between 1998 and 2002, all three types of land structure changes were likely randomly distributed. From 2003 to 2008, the structural changes were more concentrated in the eastern region of China. Significant proportional increases of subcategorical construction land were more likely to occur in the southern and eastern cities, reflecting the regional gaps in the economic development of Chinese prefectures.

Individually, the proportion of transportation land use in construction land in mostly Chinese cities, for both periods, had a significant increase. However, the spatial patterns were quite different for two periods. From 1998 to 2002, cities with an increase higher than 1% were scattered in all prefectures. From 2003 to 2008, there were more cities with 1% above increases, and most of them were concentrated in the eastern region, such as the provinces of Zhejiang, Fujian, and Guangdong (Figure 3-2). To identify the spatial dependence of the structure change of construction land use, we calculated the Moran' I for both periods. The Moran's I value increased from 0.035 increased to 0.196 for the period of 2003-2008. The agglomeration phenomenon of structure change of transportation land was more significant in the second period.

For the industrial land use, the structural increases were concentrating in the eastern region of China. In the first period, there were some cities having a noticeable decrease in industrial land proportion, which can be explained by the industrial restructuring process. For example, local governments closed many state-owned enterprises because of industrial restructuring required from central government. Between 2003 and 2008, the cities with a high-level increase sprawled to almost the entire area of eastern China, such as entire Jiangsu, Zhejiang, Fujian provinces. Interestingly, even if Beijing moved plenty of manufacturers out of the metropolitan to decrease the environment pollution for the Olympic Games, the proportion of industrial land use was still increasing for both periods (Figure 3-3). Similar to the transportation land use change, the agglomeration of industrial land use change of the second period was more significant. The Moran's I of the first period is 0.008, while the second period is 0.271.



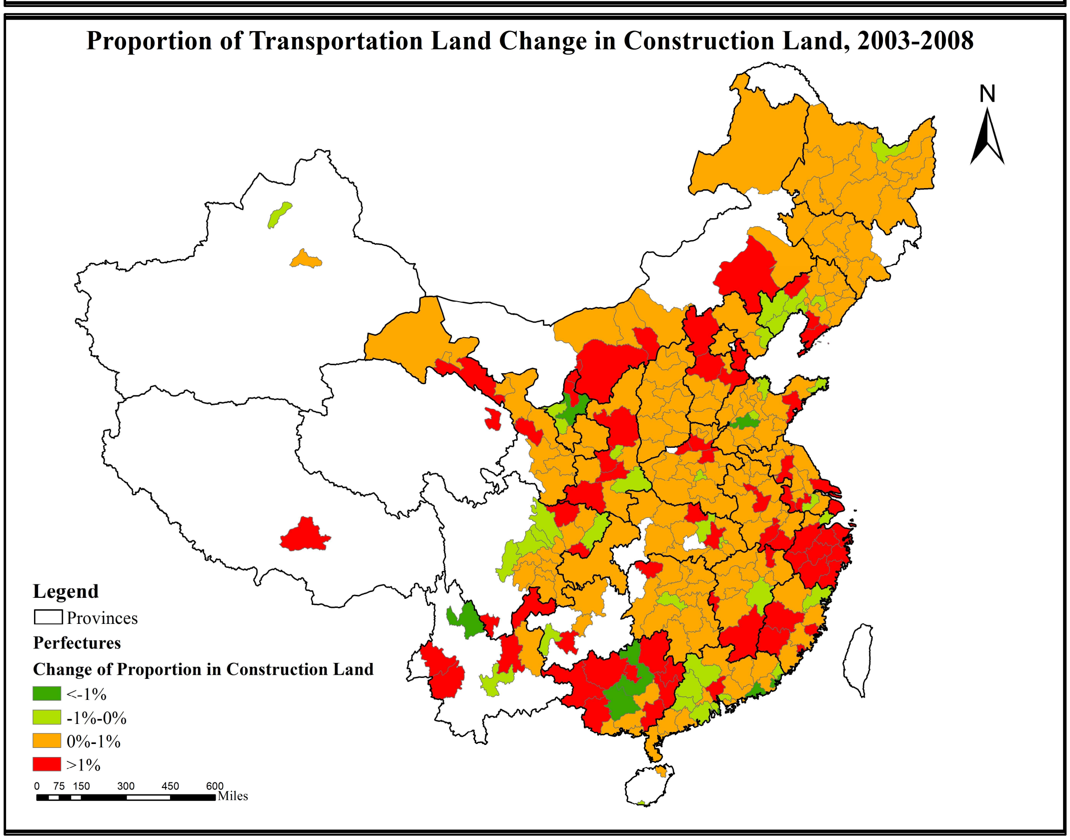
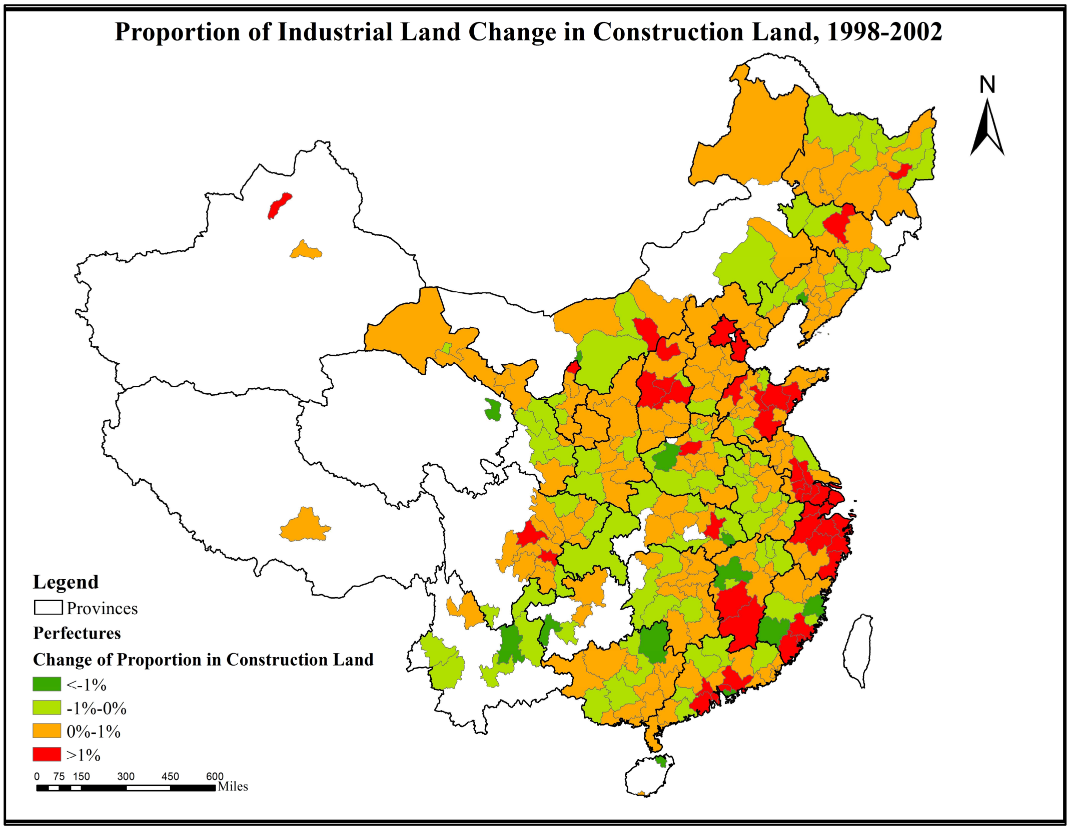


Figure 3-2 The distribution of proportion change of transportation land



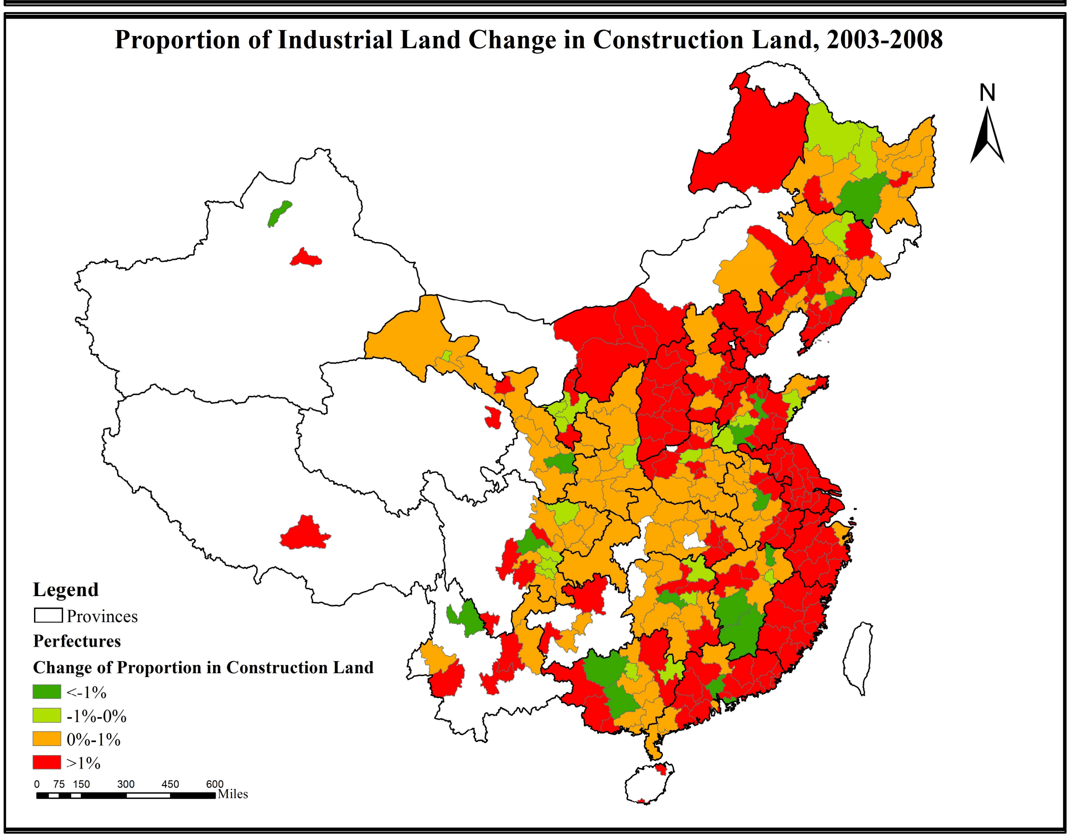
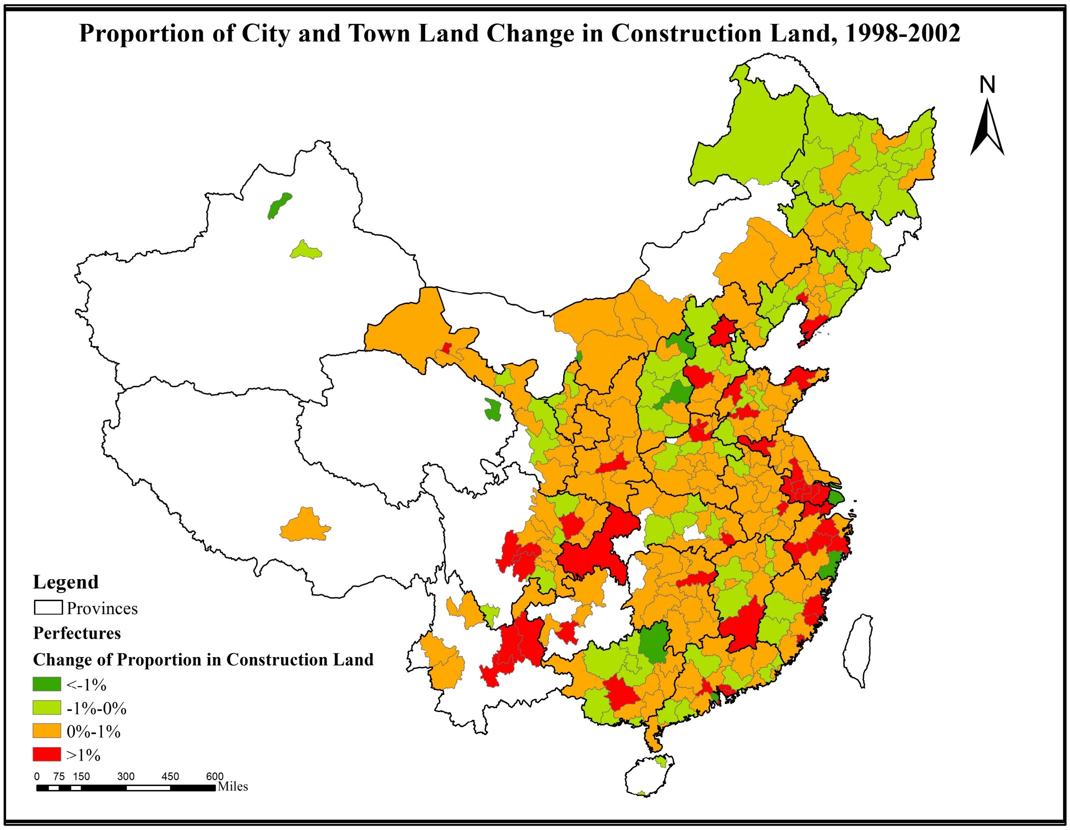


Figure 3-3 The distribution of proportion change of industrial land

During the first period, the cities with 1% increased rate were concentrated in the largest cities of China, such as Guangzhou, Chongqing, and Beijing. However, the spatial pattern changed in the second period, there were more and more southern cities having a high increase in the share of urban land (Figure 3-4). Interestingly, in Shanghai, the proportion of urban land declined from 1998 to 2008, which represents that Shanghai had a stricter planning in development (Li et al., 2015). The clustering phenomenon of the structure change of urban land use was significant for both periods. Moran's I of the first period was 0.121, while the second period was 0.143.

Regional Construction Land Use Change

To consider structural advantages and the effects of national land development, we employed the shift-share analysis to get the regional land use change of three subcategories in construction land use. For transportation land use, there was no significant spatial pattern for both periods. For regional industrial and urban land use change, the spatial patterns were clearer. Between 1998 and 2002, the regional share of transportation land change larger than 20 km^2 was concentrated in Shanghai, Beijing, and Shenzhen. The cities that have a positive regional share of transportation land use distributed in eastern China, especially in the Jiangsu and Zhejiang province (Figure 3-5). Based on the map from 2003 to 2008, we found that during these six years, the largest cities had a negative regional share of transportation land use, which suggests that there was the transformation of transportation land development from the large cities to the small cities. Almost all the cities located in the Yangtze River Delta had a positive result of regional share.



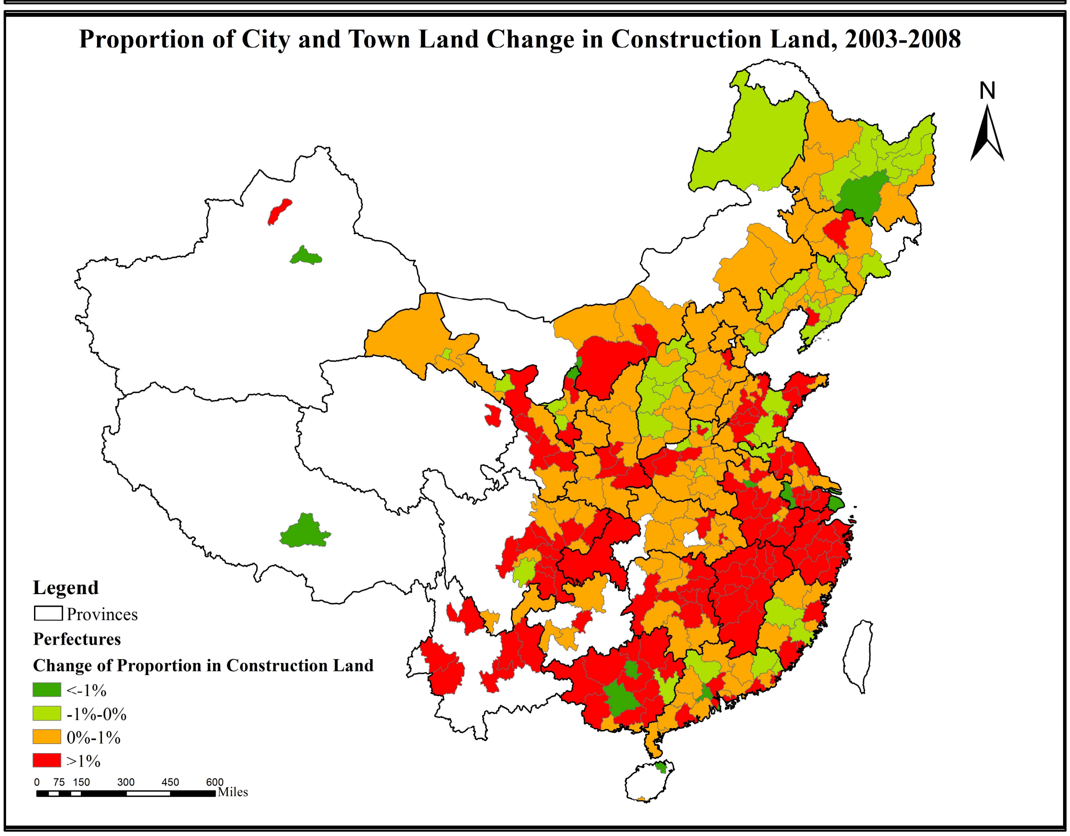
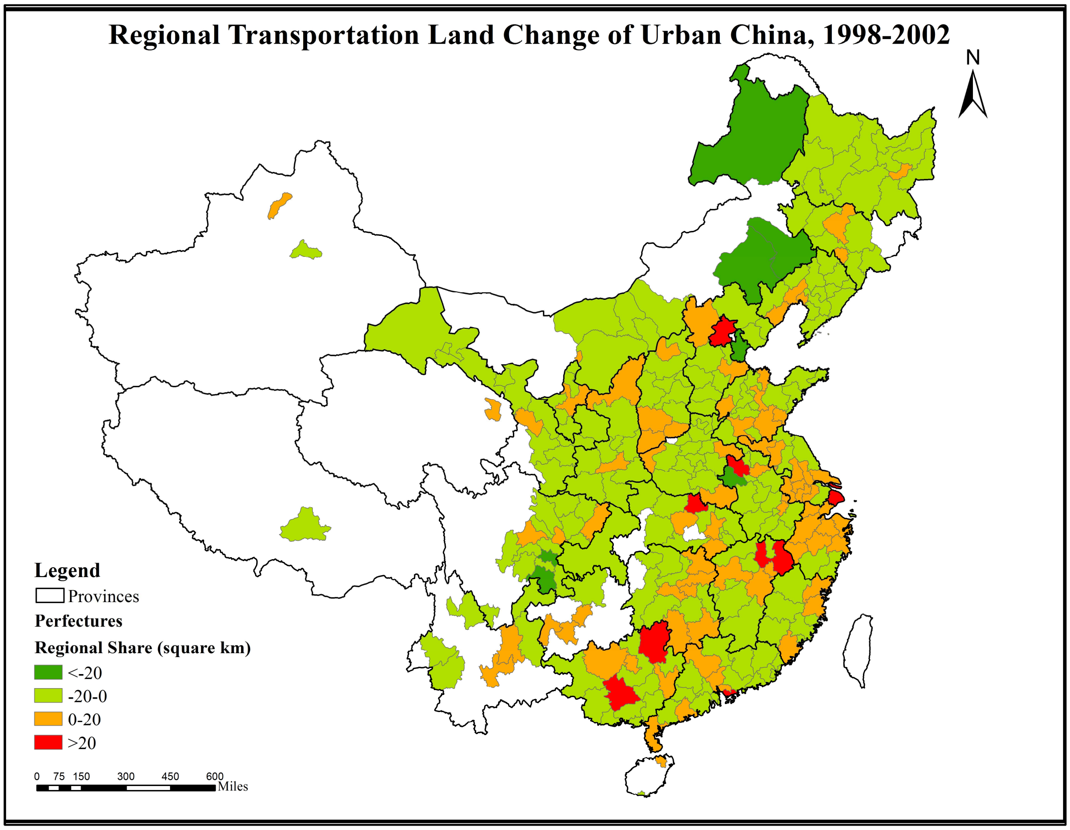


Figure 3-4 The distribution of proportion change of urban land



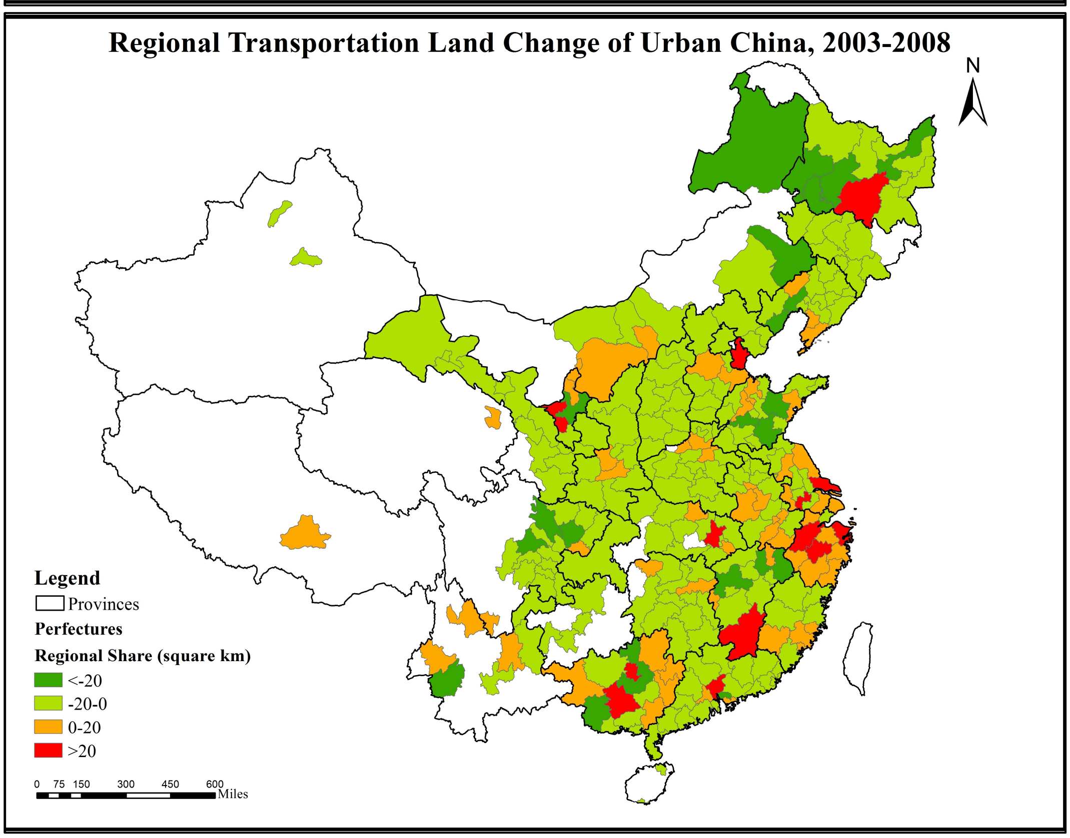
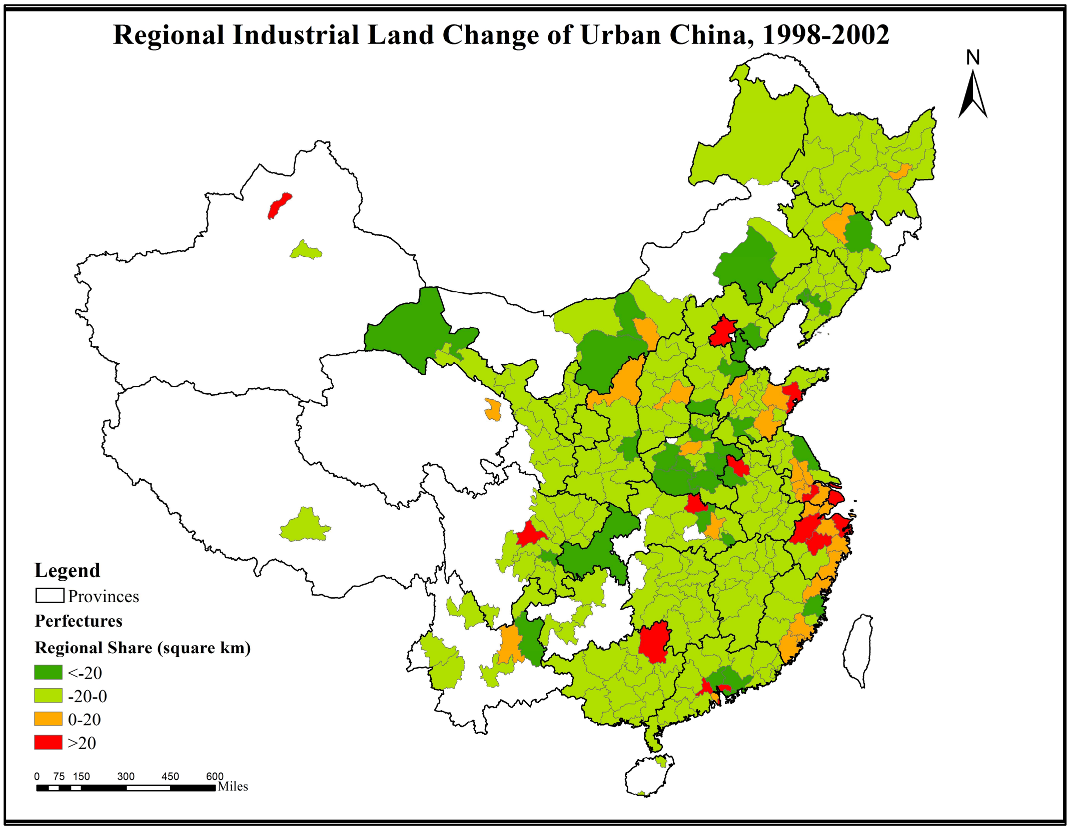


Figure 3-5 The distribution of regional share of transportation land

From 1998 to 2002, the cities with a high regional share of industrial land change were concentrated in some largest cities and eastern region of China. Between 2003 and 2008, this kind of cities expanded to the neighbor cities of the large cities, which reflects that the manufacturers were moving from large cities to the neighbor cities. The most remarkable example of this phenomenon was Shanghai and its neighbor cities. Between 1998 and 2002, the regional industrial land expansion in Shanghai was higher than 20 km^2. However, according to the map of 2003-2008, all the cities around Shanghai had a regional share which is higher than 20 km^2, while the value of Shanghai reached to -20 km^2 (Figure 3-6). The Moran's I of regional industrial land change increased from -0.0161 to 0.191, which implies that the clustering phenomenon of regional industrial land change obviously existed for the second period. We found that the development of the urban land was faster than the development of transportation land and industrial land. For both periods, the prefecture which has the highest regional share of urban land use change was Chongqing, the fourth direct-controlled municipality of China (Figure 3-7). Similar to the industrial land use change, the clustering phenomenon of regional urban land use change was significant in the second period.

Determinants of Regional Construction Land Use Change

To avoid the effect of multicollinearity on the models, we tested the variance inflation factor (VIF) of each independent variable and found that all the VIFs are smaller than 4. Table 3-3 demonstrates the result of spatial lag regression in this study. Table 3-4 presents the summary statistics of the GWR parameter estimates for six models with 283 observations.



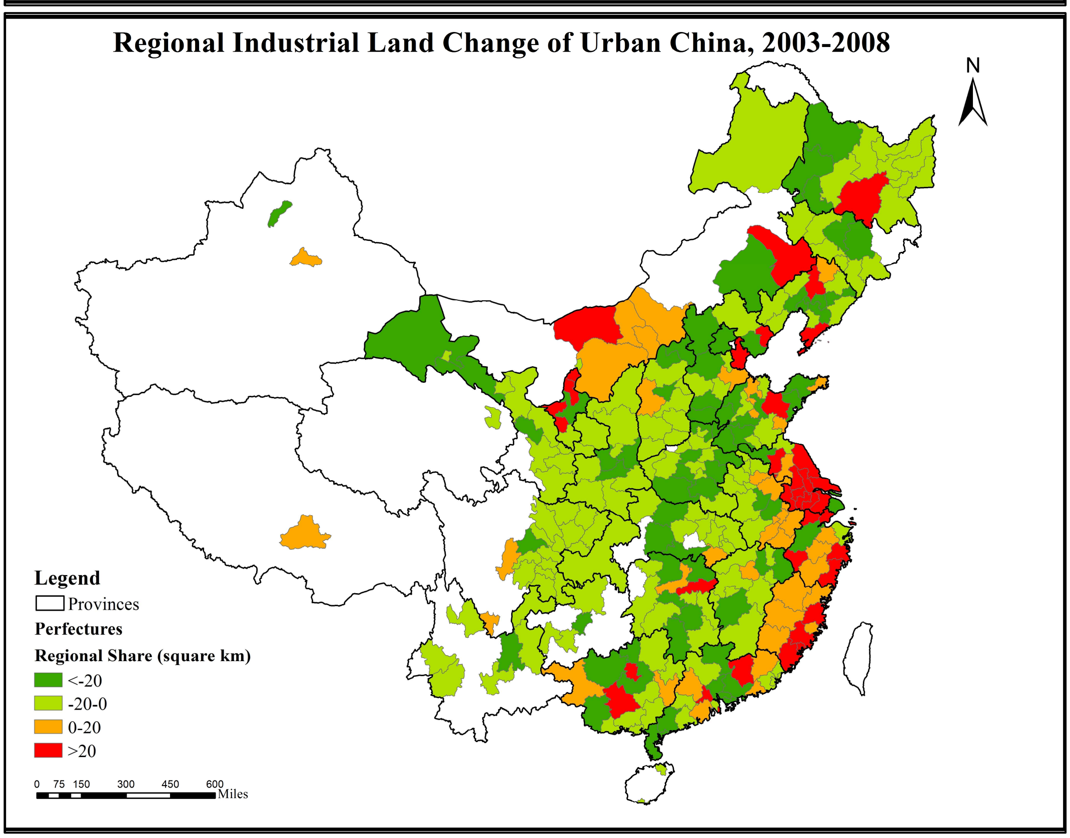
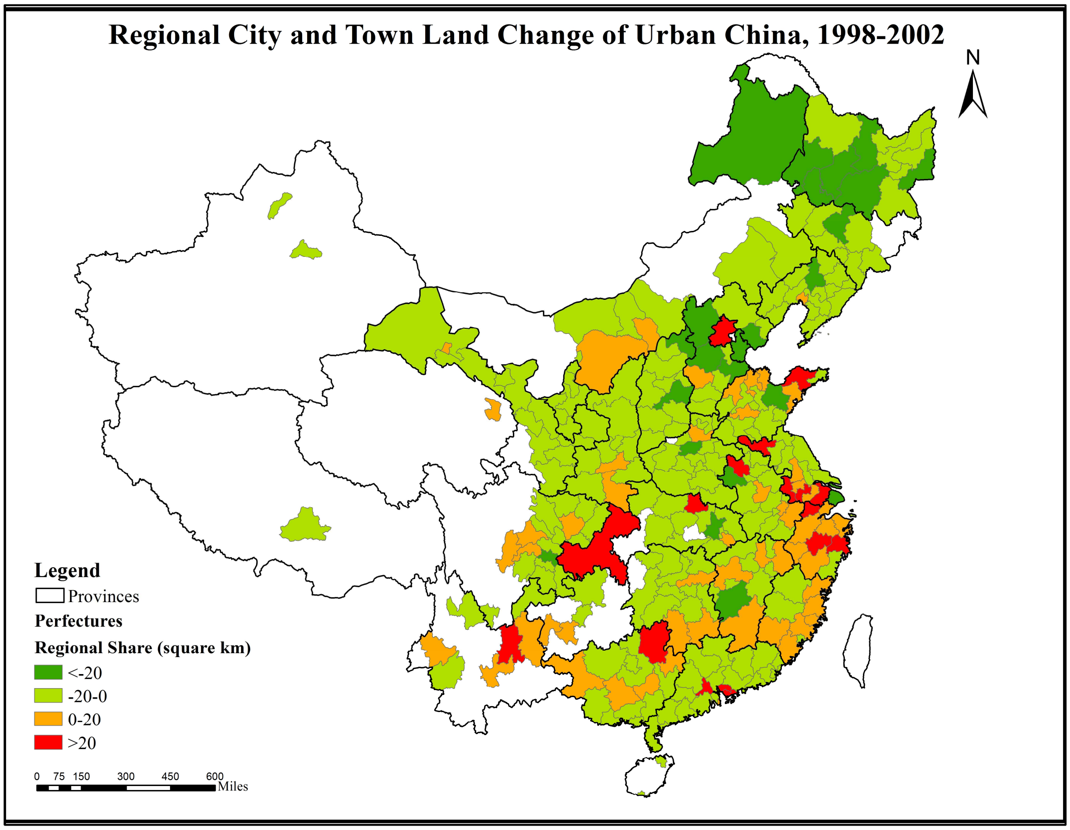


Figure 3-6 The distribution of regional share of industrial land



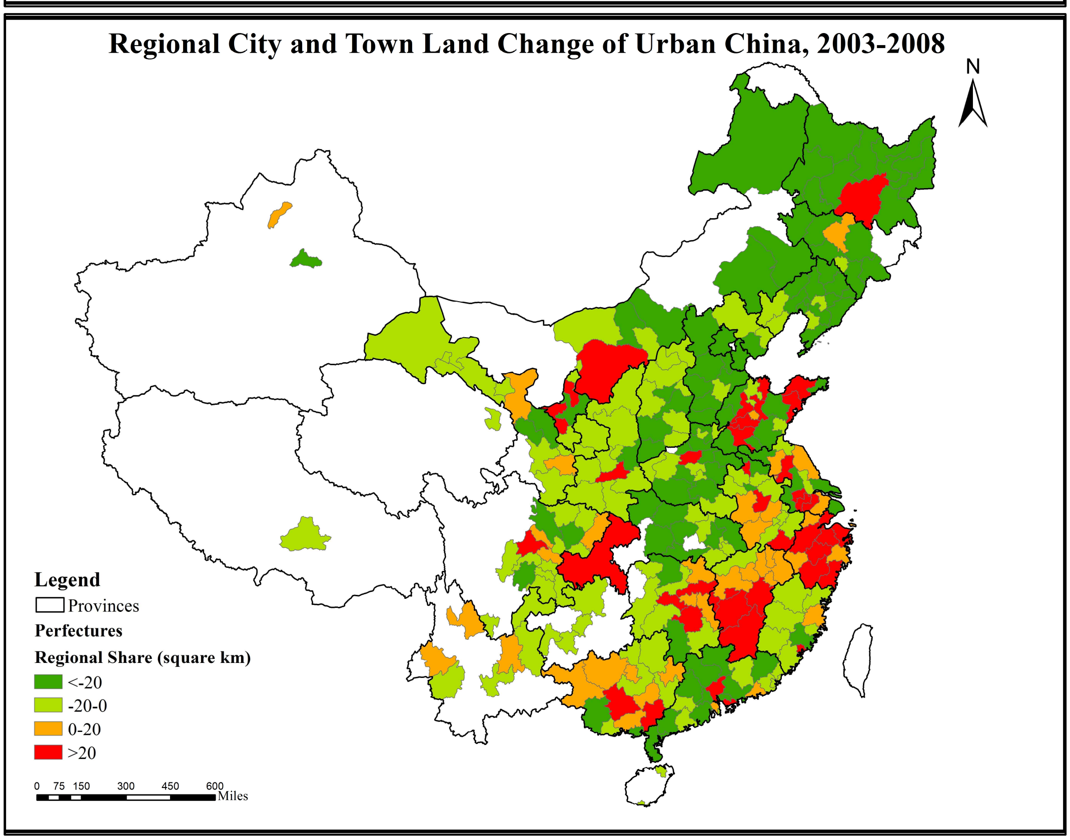


Figure 3-7 The distribution of regional share of urban land

Table 3-3 Spatial lag regression result

Variables	Transportation Land		Industrial Land		Urban Land	
	1998-2002	2003-2008	1998-2002	2003-2008	1998-2002	2003-2008
Weight	-0.035	-0.023	-0.039	0.229***	0.194***	0.220***
Intercept	-12.16***	-9.713***	-12.801*	-4.786	-17.425***	-14.364***
Urbanization						
UB	-4.347	29.581**	-4.737	25.98	26.661*	133.509***
Industrial Restructuring						
SI	-11.010*	8.868	18.010*	59.108**	-6.233	9.064
Decentralization						
OUTP	8.516*	7.563	44.422**	-64.287***	-53.411***	-52.393**
Globalization						
FDI	9.219	-9.168**	47.192	34.984***	38.749	11.567
Marketization						
NSOE	2.822*	-1.537**	1.710	-5.155***	2.355	-1.846
Accessibility						
ROAD	0.589**	0.183	-0.557	0.991**	0.308	0.239
AIRPORT	-1.217	3.148*	2.280	2.618	3.025	10.93**
Control Variables						
GDP	0.646***	0.0633	0.434	-0.097	0.959**	0.089
PD	0.007*	0.020	-0.004	-0.035	0.001	0.097
R^2	0.153	0.171	0.132	0.228	0.139	0.176
Likelihood Ratio Test	0.148	0.084	0.177	9.573***	4.910***	7.660***

*Note: Observations: 283; *** p value < 0.01; ** p value < 0.05; * p value < 0.10*

Table 3-4 Geographical weighted regression result

Variables	Transportation Land				Industrial Land				Urban Land			
	1998-2002		2003-2008		1998-2002		2003-2008		1998-2002		2003-2008	
	Mean	Positive %	Mean	Positive %	Mean	Positive %	Mean	Positive %	Mean	Positive %	Mean	Positive %
Urbanization												
UB	-2.42	16.96	15.04	86.57	29.78	97.53	-19.31	58.30	41.42	95.05	101.21	100.00
Industrial Restructuring												
SI	-10.64	0.00	6.47	64.66	12.52	79.22	39.75	88.69	-9.45	25.44	7.22	59.36
Decentralization												
OUTP	8.19	100.00	10.00	73.85	11.70	88.02	-62.76	8.83	-35.81	32.86	-17.86	36.75
Globalization												
FDI	10.25	100.00	-11.85	0.00	78.34	99.64	46.70	100.00	69.76	88.33	8.99	56.18
Marketization												
NSOE	2.84	100.00	-1.40	0.35	1.58	81.33	-5.06	0.00	2.31	76.67	-0.55	33.92
Accessibility												
ROAD	0.56	100.00	0.11	80.91	-0.30	44.36	0.78	93.99	0.44	69.61	0.15	73.49
AIRPORT	-1.36	0.00	2.72	81.98	-0.05	41.19	5.67	96.47	2.98	86.92	11.13	95.05
Control Variables												
GDP	0.70	100.00	0.04	55.83	0.68	70.07	-0.38	5.30	1.02	95.05	0.01	64.31
PD	0.01	100.00	0.01	62.19	-0.02	22.89	-0.12	23.32	-0.01	15.19	0.03	80.21
R^2	0.22		0.37		0.76		0.66		0.52		0.43	

Note: Observations: 283

First, we found that different types of land use changes linked with economic transitions in different manners. For the transportation land use, the determinants are accessibility, decentralization, economic growth, and population density. This result is similar to what we expected because decentralization should be the major impetus after this kind of land development. Based on the result of industrial land use model, we found that the geographical weight, industrial restructuring, globalization, and decentralization are significantly positive (Wang et al., 2012).

In the model result of regional urban land use change, we found that regional urban land use change is determined by the geographical weight, urbanization, and decentralization. Amongst, urbanization and weight have a strong positive association with urban land use change. The decentralization has a strong negative relationship with urban land regional use change.

Second, the mechanisms of regional land use change in Chinese cities are associated with the time factors. For instance, the determinant of transportation land changes from decentralization to urbanization. In the models of industrial land, the globalization becomes increasingly significant. We found that GDP has the most solid positive influence on the first period models, which consists with the earlier planning motivation of Chinese local government, higher GDP. Since the 21st century, Chinese governments have changed their developing strategies from chasing pure high GDP to a higher comprehensive competition.

Third, both the spatial lag regression and GWR suggest that the geographic location and clustering phenomenon matter in the regional construction land use change in China. For different cities, the mechanisms of regional urban land use change are diverse. Most of the parameters of GWR have both the positive and negative values. From a spatial perspective, the mechanisms of regional land use change for each city are different.

Figure 3-8 reveals the parameter surfaces of decentralization in the model of transportation land use, globalization in the model of industrial land use and urbanization in the model of urban land use. We could found that, for all these figures, the high-value coefficients concentrate in the eastern and southern area of China. In transportation land use, the influence of decentralization transfers from Guangdong province to the northeastern area of China from 1998 to 2002. In the first period, the impact of FDI on the industrial land use change is focusing on the eastern part of China, while in the second period, the impact expands to the all the regions of China. Similar to the patterns of impacts from FDI on industrial land, urbanization has more effects on the regional urban land increase in eastern regions. These maps also support that the mechanisms of construction land expansion differ across the geographic locations.

Conclusion

In the context of economic transition, the triple processes of decentralization, globalization, and marketization are broadly used to explain the economic growth, urbanization, and construction land use change (Wei, 2012, 2015; Wei & Ye, 2014). This paper focuses on three subcategories of land use changes in Chinese cities: transportation, industrial, and urban land. By introducing the shift-share analysis to land use change studies, we evaluated their regional urban land use changes and analyzed the underlying determinants of each kind regional land use change.

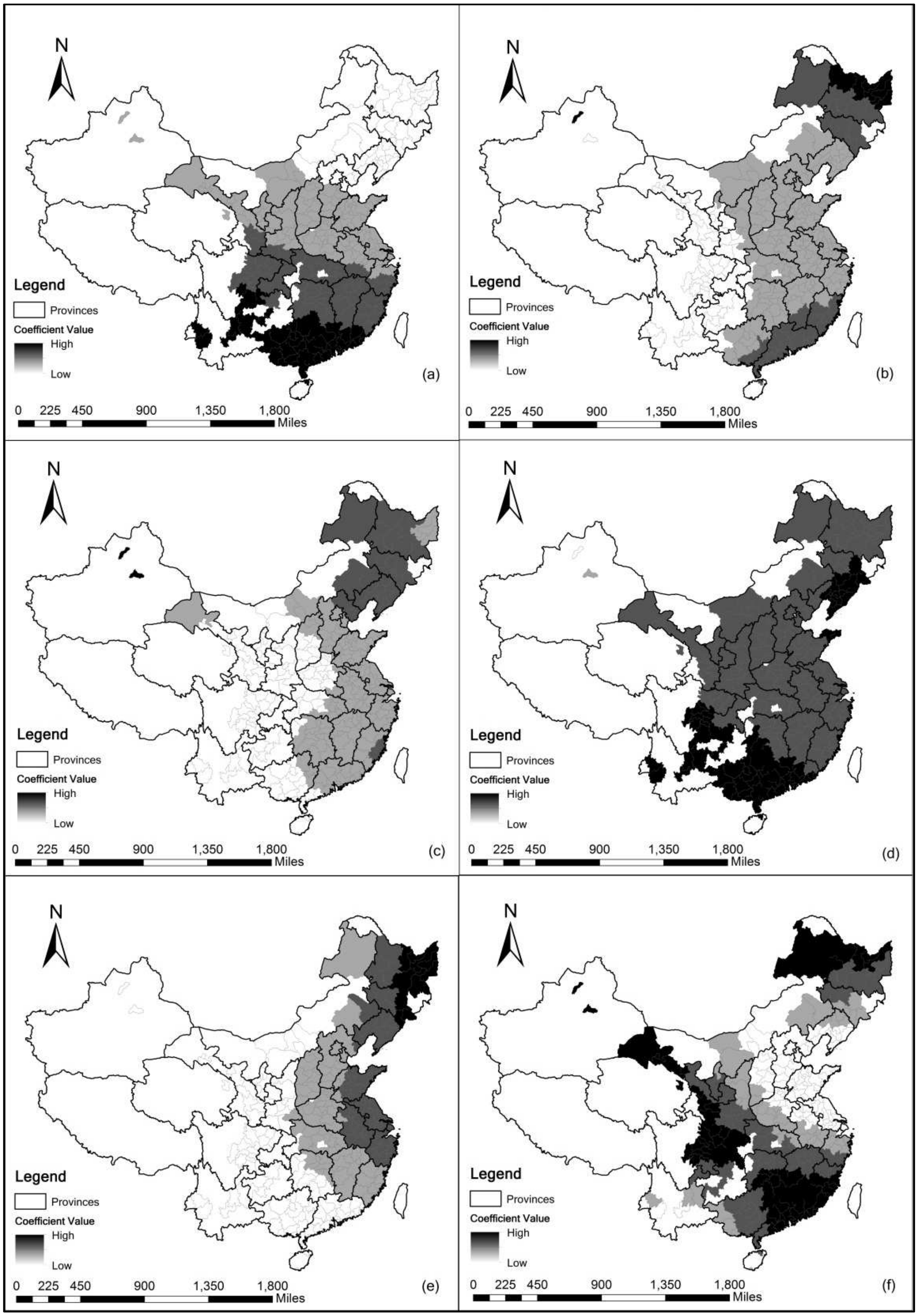


Figure 3-8 GWR parameters surfaces
(*OUTP* in regional transportation land change 1998-2002 (a), 2003-2008 (b); *FDI* in regional industrial land change 1998-2002 (c), 2003-2008 (d); *UB* in regional urban land use change 1998-2002 (e), 2003-2008 (f))

The construction land increase concentrated in the eastern region of China. Moreover, determinants of land use change differ across locations, study periods, and land use types. For urban land use, urbanization is the most significant driving force, while, for industrial land use, FDI, and industrial restructuring, geographic factors are the dominant impetus. The regional transportation land changes are sensitive to the process of decentralization and the variables of accessibility. Our model results advance our understanding of regional urban land use change, not only highlighting the spatial patterns of this process but also demonstrating the well-documented driving forces based on the economic transition background. By quantifying the underlying determinants in the change in the subcategories of construction land, we conclude that considering the structural advantages and the spatial effect will result in a better understanding of rapid urban growth in China.

The findings also have profound policy implications for land use planning at the national level. There is still a significant spatial inequality of construction land expansion between eastern regions and other regions. Regional urban land use developments sometimes are moderately massive without considering the sustainability of economic developing and protecting the environment. Furthermore, the temporal gaps of mechanisms also reveal that there is not a long-term and effective land use policy for Chinese local government. Such attention will further the understanding of a theoretical framework regarding regional construction land change and enlighten the detailed determinants for subcategories urban land expansion.

Finally, it is worth to point out that the triple-process, urbanization, and accessibility cannot fully explain all the kinds of the regional land structure change perfectly because the political system and local government are still playing proactive roles in China's urban growth.

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CHAPTER 4

URBAN LAND EXPANSION AND SPATIAL DYNAMICS IN GLOBALIZING SHANGHAI[2]

Abstract

After the two chapters with a national scope at prefectural level, this chapter turns to a case study in Shanghai and its development zones (DZs). We find that, as nodes of the global-local interface, the DZs are the most significant components of urban growth in Shanghai, and major spatial patterns of urban expansion in Shanghai are infilling and edge expansion. We apply logistic regression, geographically weighted logistic regression (GWLR), and spatial regime regression to investigate the determinants of urban land expansion including physical conditions, state policy, and land development. Regressions reveal that, though the market has been an important driving force in urban growth, the state has played a predominant role in the implementation of urban planning and the establishment of DZs to capitalize fully on globalization. We also find that differences in urban growth dynamics exist between the areas inside and outside of the DZs. Finally, this paper discusses policies to promote sustainable development in Shanghai.

[2] Adapted from Li, H., Wei, Y. H. D., & Huang, Z. (2014). Urban land expansion and spatial dynamics in globalizing Shanghai. *Sustainability*, *6*(12), 8856-8875.

Introduction

Chinese cities have been experiencing drastic land expansion and spatial restructuring since economic reform began in 1978. Land expansion in Chinese cities has caused serious issues about the social justice, regional development, and environment protection (Bai, Shi, & Liu, 2014). Shanghai, the China's leading global city, located in the Yangtze River Delta, has been undergoing significant urban growth after 1990 when the central government established the Pudong New Area. Between 1993 and 2009, the city's built-up area increased from 300 km^2 to 886 km^2, with a 6.5% annual growth rate (SSB, 1994, 2010). Moreover, similar to the most cities in China, the land development of Shanghai is the result of interactions between the market and state (Han, Hayashi, & Cao, 2009; Wu, 2000, 2003; Yue, Liu, & Fan, 2010). Therefore, urban growth of Shanghai is the typical example of urban development in China, and better understanding and managing of land expansion in Shanghai are critical to the development and sustainability of the global cities in China.

The existing studies about the process of urban growth in China are confined in the two perspectives, and both of them have a weakness (Li & Wu, 2006; Wu, 2000; Yue, Liu, & Fan, 2013; Zhang, Zhou, Chen, & Ma, 2011). The first perspective has argued that urban growth in Chinese cities is led by the state and the market (Lin & Wei, 2002; Wei, 2012; Wei & Li, 2002; Wu, 2003). However, this debate has never been addressed by the quantitative methods. This school also investigates land use change in the development of development zones (DZs) in Chinese cities, with focusing on the inside changes, but ignores the underlying dynamics of the DZs' impact on urban growth (Cartier, 2001; Wei & Leung, 2005). Other scholars from geographic perspective have demonstrated that the urban growth in China is influenced by the accessibilities and neighbor land use types (Luo & Wei, 2009; Schneider & Mertes, 2014). Apparently, these geographic perspective studies cannot describe the whole picture of impetus after urban growth in Chinese cities because of lacking institutional components. Therefore, both of these two perspectives fail to explain the urban growth in Chinese cities thoroughly.

In addition to the mechanisms studies of urban growth in Chinese cities, the spatial patterns of land expansion in urban China also draws plenty of attention (Liu, Liu, Zhuang, Zhang, & Deng, 2003; Liu, Yue, & Fan, 2011; Schneider, Seto, & Webster, 2005). Based on the spatial analysis, they identify three major patterns of urban land expansion in China: infilling, expansion, leapfrog (Camagni, Gibelli, & Rigamonti, 2002; Forman, 1995; Wilson, Hurd, Civco, Prisloe, & Arnold, 2003). However, underlying shaping processes of these patterns and their linkages to the powers of state and market are neglected by most geographers. Moreover, there is not a specific literature to date demonstrating the patterns of land expansion in Shanghai. To fill the literature gaps we mentioned above, in this study, we identify the extents and spatial patterns of urban land expansion in Shanghai from 1991 to 2010, based on a patch analysis of land use images. In particular, we evaluate urban growth and its patterns in the Pudong district and the development zones in Shanghai. Moreover, by applying global logistics regression, logistic spatial regime regression, and logistic geographically weighted regression (logistic GWR) to investigate the interaction between development of urban land and accessibility, planning, state policy, and neighborhood land use, we understand the mechanisms of urban growth in Shanghai from both institutional and physical perspectives, and quanify the interactions between state and market powers.

Literature Review

The school studying mechanisms of urban growth in China with an economic and geographic perspective using statistical, remote sensing, and geographic information system (GIS) techniques to investigate the relationship between the urban growth, economic development, accessibility, and the neighborhood effects (Deng, Huang, Rozelle, & Uchida, 2006, 2008; Liu & Zhou, 2005; Luo & Wei, 2006, 2009; Schneider & Mertes, 2014; Tan, Li, Xie, & Lu, 2005). They have found that adjustment of economic structure (Lin & Ho, 2005), economic growth (Tian & Ma, 2011), development of transportation system (Ma & Xu, 2010), increasing of tertiary industry and average salary (Ding & Lichtenberg, 2011), and the large numbers of migration from rural area to urban area (Wang, Chen, Shao, Zhang, & Cao, 2012), are important impetuses for urban growth in China.

In the studies of land expansion in China, the institutional perspective examines the process of economic transition in China, and its influence on local governance, the transferring of land use rights, conversion of land uses, contradictions between different sorts of planning, and planning's implementation (Wu, Xu, & Yeh, 2007; Yang & Wang, 2008). Since the 1990s, there has been significant debate about whether the market or the state is more responsible for urban growth in China because the economic transformation is a gradual process in which the market system and planning system coexist (Wu, 2000, 2003). Some scholars conclude that urban growth in Chinese cities is impacted by globalization, marketization, and decentralization (Wei, 2001, 2015). They also describe the process of administrative change and explain how these changes led to urban growth in China (Wu & Yeh, 1999; Xu, Yeh, & Wu, 2009; Xu & Zhu, 2008). Moreover, the agents of planning and regulations' implementation, local governance, as well as their agents, local government in China arouse extensive discussions (Ho & Lin, 2004; Ma, 2005; Wei, 2012).

The development zone fever in China also becomes a popular academic issue on investigating the urban growth in China (Carter, 2001). Because the DZs in China are established to attract foreign investment and exploit globalization, foreign investment has become one of the most significant indicators influencing the spatial and structural transformation of urban China (Wei & Leung, 2005; Wu, 2000, 2003). Scholars have examined the relationship between land administration systems and the development of DZs, and other scholars have focused on the urban land use change inside of development zones. As stated by the institutional scholars, the decentralization of urban governance fundamentally transferred control of urban development from the central government to local government. For instance, since 1990, the district governments have progressively gained a group of administrative powers, which have been used in urban planning. Moreover, since 1992, the right of land use planning was given to the district and county governments now responsible for preparing detailed development plans. However, this division of power between the municipal and district government differs from city to city, causing differences in the patterns and dynamics of urban growth across cities (Wei, 2012; Wu, 2000). Deng and Huang (2004) has pointed out state planning such as establishing DZs plays a significant role in urban growth of Beijing, while some scholars have found that the multienterprise and foreign investment have become major driving forces of urban expansion in cities located in the Pearl River Delta (Liao & Wei, 2014; Ma & Xu, 2009).

The different dynamics of urban expansion lead the dissimilar spatial patterns of urban growth. Plenty of empirical studies about particular Chinese cities' expansion (Liu et al., 2003; Liu et al., 2011; Xie, Batty, & Zhao, 2007; Yue et al., 2010), have been done, and they have repeatedly found that the patterns are different across cities due to dissimilar geographic and economic conditions. For example, Changchun expanded mainly along the traffic route as the corridor-type before the economic reform, but since the reform, the patterns transformed to infilling and expansion. In Chengdu, geographers have found that the pattern before 2000 is a major expansion based on the road, but after 2000, infilling and leapfrog became the major patterns of urban growth (Schneider et al., 2005). Xu et al. (2007) observed that the major pattern of Nanjing transformed from expansion to infilling and leapfrogging since 1988. The sprawl of Beijing has always been based on the urban traffic loop, a concentric circle (Xie et al., 2007), while Hangzhou and Wuhan show the typical polycentric expansion patterns (Liu et al., 2011). Based on these examples, we found that there is not a simple one-pattern works to describe development and expansion in all Chinese cities.

Based on above reviews, there are five areas deserve further research efforts. First, even if the debate about state and market and their interactions is popular in studies about the mechanism of urban expansion in China, there is no a research address this debate quantitatively. Second, the question of how these drivers of urban growth in Chinese cities vary across different institutional, geographic, and economic conditions also should attract more attention. Third, most geographers neglect the underline dynamics which shaping these different spatial patterns of land expansion in urban China. Fourth, there is a dearth of literature concentrating on the site decision of the DZs and the underlying dynamics of the DZs' impact on urban growth in Chinese cities. Fifth, though this sort of research has been popular among geographers who interested in urban growth in Chinese cities, no research to date specifically addresses the patterns and dynamics of Shanghai's expansion, leading to the absence of a clear description and identification of urban growth of Shanghai.

Data and Methodology

Study Area

Shanghai, the largest city in China, has a registered population of nearly 18.4 million in 2008 and a total area of 6340.5 km^2 (SSB, 2009), and sits at the mouth of the Yangtze River in the middle portion of the Chinese coast. The municipality borders the provinces of Jiangsu and Zhejiang to the north, south and west, and is bounded on the east by the East China Sea. From 1949 to 1978, Shanghai was the manufacturing center of China, and the urban land use was concentrated in the west area of the Huangpu River. However, since 1979, the special economic zones (SEZs) have emerged as the center of foreign and domestic investment, while Shanghai has had relatively low economic and urban growth. From the beginning of the 1990s, the central government has granted the municipality greater power to attract foreign and domestic investment, which resulted in an intense redevelopment of the city.

With this accelerating urbanization, Shanghai's urban territory has been continuously extended and restructured since the 1990s. In 1991, Shanghai was divided into 12 urban districts and nine suburb counties. In 2010, the number of districts in Shanghai increased to 19. In 2009, the Nanhui district became part of the Pudong New Area, but in this study, we keep the traditional boundaries of the Pudong District, because the policy effect on Pudong during 1991 to 2010 is still concentrated in the traditional Pudong District. Due to the urban land expansion of Shanghai, which is concentrated east of the Huangpu River and the availability of the data source, we selected eastern Shanghai, including 13 districts in our study area (Figure 4-1). The total of our study area was 3,030.65 km^2, accounting 47.8% of the total area of Shanghai municipality.

Data Collection and Remote Sensing

Land use data employed in this study were derived from Landsat TM and SPOT remote sensing images in 1991 and 2010. A spatial overlay operation was used to extract the conversion land map between two classified images. The other datasets needed for building the urban growth model were extracted from various data sources. The city center, ports, airports, subway stations, and suburban centers were extracted from plan scheme maps of 2010 (SPLRA, 2014). The data concerning roads and rail networks were obtained from China Academy of Urban Planning and Design, and road networks were divided into two types: intercity highways, and local artery roads. We extracted planning information from the land use planning map of 2000, while the data source for the geographic range of development zones was the Ministry of Land Resource report. We used two TM images for 1991 and 4 SPOT images in total for each year. Since the SPOT image for 1991 is gray, having just one band, we acquired TM 5 images of Shanghai in 1991 to get the color information. The resolution of the TM images is 30m*30m, while the resolution of SPOT is 10m*10m. The final image of 1991 is the result of image fusion from TM 5 and SPOT 2. The 2010 image for classification is from SPOT 5.

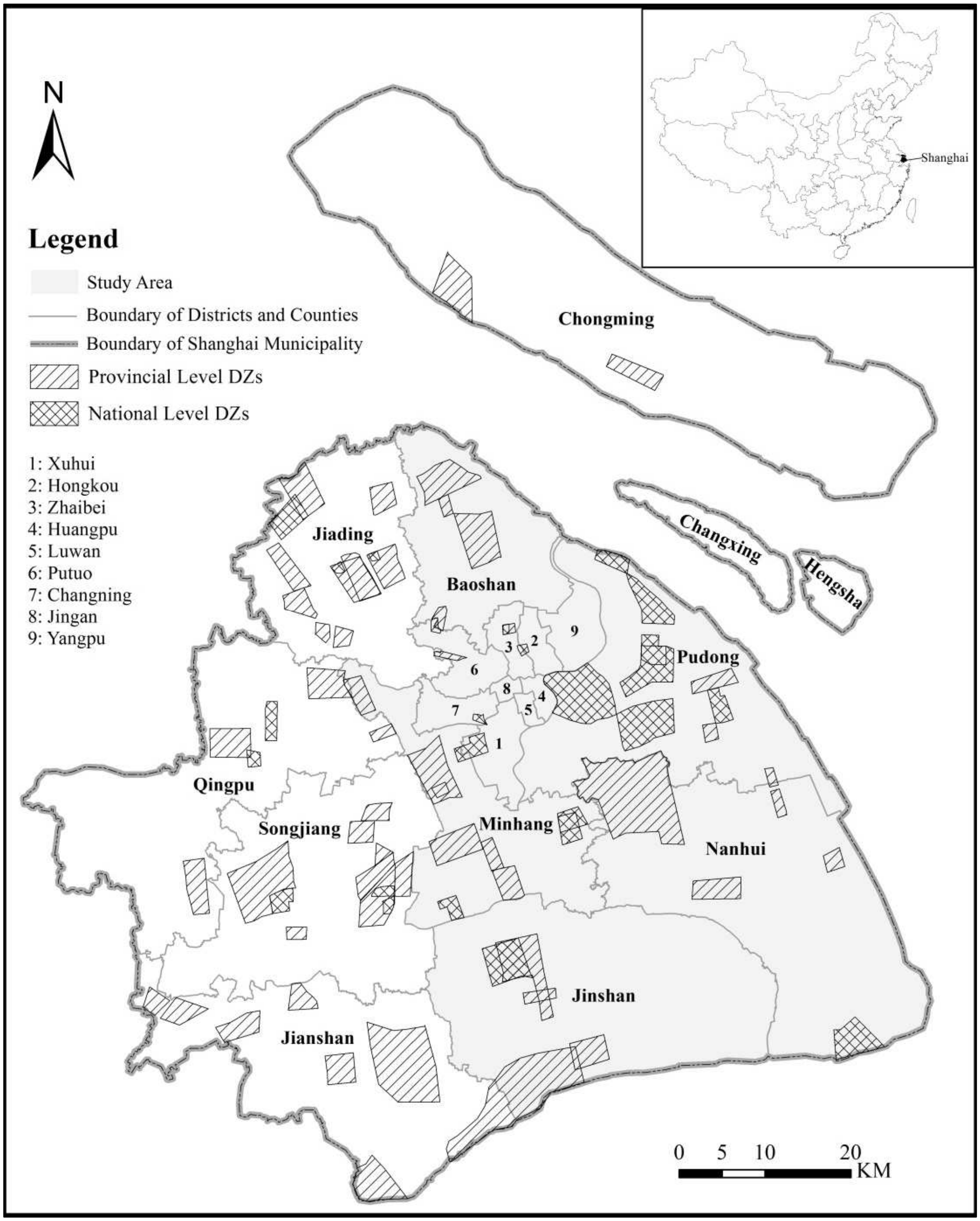

Figure 4-1 Study area

A supervised maximum likelihood classification was used to classify the georeferenced images. Four types of land use are classified in this process: construction land, agriculture, water body and forest. However, based on the NDVI index result, we found that the percentage of pixels with an NDVI value greater than 0.3 is fewer than 0.3%, which implied that there is almost no forest in our study area. Thus, we combined the agriculture land and forestland together in this study. The overall accuracies of this classification process of 1991 and 2010 are 86.27% and 92.17%, with Kappa coefficients 0.83 and 0.86, respectively. The result of classification is also corrected based on the land use survey map of 2010.

Methods

Since the 2000s, the quantitative method has been employed more commonly with the help of remote sensing technology. Most realistic large-scale applications need to consider the use of various data sources—such as historical land-use records, urban land use maps, and remote sensing images—to construct the most significant geographic features of urban development (Cheng & Masser, 2003a; Deng et al., 2006; Li & Yeh, 2000; Liu et al., 2011; Luo & Wei, 2006, 2009; Yue et al., 2013).

Following these previous studies, the model adopted in this study was based on the integration of remote sensing, the geographic information system (GIS) and spatial econometrics. We employed the remote sensing technique to get the land use map of 1991 and 2010 in raster format. The spatial analyses, including the patch analysis, sampling process and extracting the value to the sampling points, are all based on the GIS technique. These spatial analyses aim to provide the independent and dependent variables and get the distribution of the spatial patterns of Shanghai's urban expansion. The spatial econometric includes the global logistic regression, logistic spatial regime regression, and logistic GWR. We apply the global logistic regression to investigate the general dynamics of urban growth in Shanghai. The logistic spatial regime, and logistic GWR is employed to identify the different mechanism inside or outside the DZs.

Sampling and Patch Analysis

Following Liao and Wei (2014), we employed a combined systematic and random scheme for land use data sampling to ensure that sampled land use data represent the study area systematically and provide enough information on land use change. From the conservation areas, we extracted 1,752 regularly spaced points with 60 internal pixels, which captured the spatial variations of land use change. The same fishnet was also built on the nonurban land use areas in 1991. At this stage, we extracted 5,146 points, and to balance the logistic regression, we randomly selected the same numbers of unchanged points. Therefore, there are 1,752 observations, which represent the change from the nonconstruction land to construction land use, randomly distributed in the study area, while the observation number of unchanged points is 1,752 too. The regression should have 3,504 total observations. Therefore, all these observations are chosen systematically in order to provide enough samples to build unbiased logistic regressions.

Aiming to identify the spatial patterns of urban land expansion in Shanghai, and distinguish the different dynamics between Shanghai and other cities, we applied the patch analysis in GIS environment to these three different types of the typology of urban growth of Shanghai. Based on the research of Camagni et al. (2002) and Wilson et al.

(2003), we summarized urban growth patterns into three types: infilling, expansion and leapfrog development. An infill growth is defined as the development of a small tract of land mostly surrounded by urban built-up land. The expansion also represents an expansion of the existing urban built-up land patch. Leapfrog development refers to developed parcels that are converted from nondeveloped parcels outside of and unconnected with the existing urban built-up land. For the convenience of implementation, a simple quantitative method to distinguish the three growth types was proposed using the following equation (Eq. 4-1):

$$S = L_c/P \qquad \text{(Eq. 4-1)}$$

Where L_c is the length of the common boundary of a newly grown urban area and the pregrowth urban patches, and P is the perimeter of this newly grown area. Urban growth type is identified as infilling when $S >= 0.5$, expansion when $0 < S < 0.5$, and spontaneous growth, when $S = 0$ which indicates no common boundary (Xu et al., 2007).

Regressions

To identify the unique coefficient of each sample points and avoid the heterogeneity of spatial effect, we apply GWR to capture the spatially varying relationship between probability of land use conversion and explanatory variables. The idea of GWR is to assign every spatial unit as a regression point and create locally regression equations for each spatial unit based on specified weighted strategies normally using Kernel function. The GWR allows the parameters to be estimated locally, and it's taking the form as (Eq. 4-2):

$$Yi = \beta_0(u_i, v_i) + \sum_k \beta_k(u_i, v_i)X_{ik} + \varepsilon_i \qquad {}_{i=1\ldots\ldots n}$$

The equation of logistic GWR is following:

$$ln(ChangeProb_i/1 - ChangeProb_i) = C_i + \sum_k \beta_{ki} X_{ki} \qquad \text{(Eq. 4-2)}$$

Where C_i is the constant parameter, which is specific to location i: ki is the parameter of independent variable X_k at location i. Following Luo and Wei (2009), we employ the adaptive kernel function, which is based on the Gaussian distance function in this study.

We apply the spatial regime modeling to distinguish the dynamics between urban growth in development zones and out of development zones and to explore the interactions between the powers of state and market. In the Eq. 4-3, the strategy of development zones provides two new samples, which allow coefficients to vary across two different regimes: a regime of points in DZs (*A*), a regime of points outside DZs (*B*),

$$\begin{bmatrix} gr^*_{i,tA} \\ gr^*_{i,tB} \end{bmatrix} = \begin{bmatrix} Y^*_{i,t-1A} & X^*_{i,t-1A} & 0 & 0 \\ 0 & 0 & Y^*_{i,t-1B} & X^*_{i,t-1B} \end{bmatrix} \begin{bmatrix} b_A \\ \varphi_A \\ b_B \\ \varphi_B \end{bmatrix} + \begin{bmatrix} v_{i,tA} \\ v_{i,tB} \end{bmatrix} \qquad \text{(Eq. 4-3)}$$

Where the subscripts *A* and *B* indicate different regimes, $gr^*_{i,tA}$ and $gr^*_{i,tB}$ are $N \times 1$ column vector with observation for land use change possibility for spatial regimes A and B, respectively; $Y^*_{i,t-1A}$, $Y^*_{i,t-1B}$ are $N \times 2$ matrices including the constant term and the log of initial land change possibility of each regime; $X^*_{i,t-1A}$, $X^*_{i,t-1B}$ are the $N \times K$ matrices of observations on other explanatory variables for each regime; $v_{i,tA}$, $v_{i,tB}$ are the $N \times 1$ vectors of error terms (Cravo & Resende, 2013).

Variables

Following the work from Liao and Wei (2014), Luo and Wei (2009), we choose the probability of nonurban to urban land conversion from 1991 to 2010 as the dependent variable for the proposed logistic models including global logistic regression, logistic GWR and spatial regime regression, with values of 0 (no conversion) and 1 (with conversion). Based on the primary concerns of previous research (Luo & Wei, 2009; Wu, 2000), we apply three types of explanatory factors in the land use model: the attributes of the market, the attributes of urban growth patterns, and the attributes of state powers (Table 4-1).

Market behaviors mostly reflect the profits of the development. The variable, distance to local artery roads, represents the control of location decision in urban growth by the market power. According to previous studies, some geographers pointed out that neighborhood land use conditions have a significant effect on land use transition (Luo & Wei, 2009; Wu & Yeh, 1997). These neighborhood variables could represent the cost of urban land development. Therefore, we considered three neighborhood variables in our model: density of agriculture land, the density of construction land, and density of water body (Cheng & Masser, 2003b).

To understand the expansion pattern of Shanghai—individual-core, multicore, and along the Huangpu River—we build three variables to capture this feature of Shanghai: distance to major city center; distance to the Huangpu River; and distance to subadministration centers. Our expectation is that if the city follows an individual core pattern, the variable of distance to the major city center should be negatively significant, and if the city follows the multicore development pattern, the distance to subadministration centers should be significantly negative. Moreover, if Shanghai develops beside the Huangpu River, the variable of distance to Huangpu River will be significantly negative (Forman, 1995).

Table 4-1 Variables

Abbreviations	Description	Type
	Response Variables	
VC	Probability of land conversion	*Dummy*
	Predictor Variables	
	Market	
DLW	Distance to local artery roads	*Continuous*
DEA	Density of agriculture land	*Continuous*
DEC	Density of construction land	*Continuous*
DEW	Density of water body	*Continuous*
	Urban Growth Patterns	
DC	Distance to major city center	*Continuous*
DHPR	Distance to the Huangpu River	*Continuous*
DSC	Distance to subadministration centers	*Continuous*
	State	
VDZ	Development Zones	*Dummy*
VP	Land Use Planning	*Dummy*
PD	Pudong District	*Dummy*
DHW	Distance to intercity highway	*Continuous*
DRL	Distance to railways	*Continuous*
DAA	Distance to airports	*Continuous*
DPP	Distance to ports	*Continuous*
DSWS	Distance to subway stations	*Continuous*

The intercity highways, subway stations, airports, seaports, and railways are integration mechanisms of the urban transportation system and the main projects of the local governments. Thus, the distance to these objectives could be interpreted as the state power effects (Luo & Wei, 2009; Wu & Yeh, 1997). Moreover, we added the policy effect variables in this land use model to assess whether or not the state policy and land use planning drive the city. The variables are dummy variables; one means the sample point belongs to the development zones, planning areas or the Pudong district, while zero represents a sample point that is not located in the DZs, planning areas or Pudong district. The area of development zones includes the national level DZs and provincial level DZs.

Methodologically, all variables of the distances are calculated from the sampled points to near features by Euclidean distance in ArcMap. The neighborhood defined for the three density variables is the average value of raster in the square with a side length of 100m, which is calculated from a focal function in ArcGIS. We also employed a intersect function between layers in ArcGIS to get these dummy variables.

Land Use Change and Spatial Patterns Analysis

Land Use Change in Shanghai

To measure the magnitude and patterns of urban land use change in Shanghai, we compared the two classification results of remote sensing images and found that, from 1991 to 2010, the construction land area of eastern Shanghai increased 378.48 km^2, and the increase rate was 38.45% (Table 4-2). The scale of expansion of urban land in Shanghai is higher than most other cities in China. On the other hand, this whole study area also lost nearly 15% of agriculture land and 50% of its water body due to an extensive sea area being converted from sea to construction land to develop new modern ports and harbors. In Pudong, the similar process also can be found. The Pudong New Area had a 41% increment of construction land, and the speed of losing agriculture land is higher than the average speed of the study area.

Spatially, in 1991, most areas of the center district were covered by construction land. By 2010, we found that most expansions were concentrated in the neighbor districts of the central area (Figure 4-2), such as Baoshan, Minhang, and Pudong. Because the areas of these three districts are much larger than center districts, the range of land expansion is relatively extraordinary.

Table 4-2 Land use change in eastern Shanghai and Pudong

Land Use Type	Eastern Shanghai			
	1991(km^2)	2010(km^2)	Change(km^2)	% of Change
Construction	984.45	1,362.93	378.48	38.45
Water Body	174.85	88.86	-85.99	-49.18
Agriculture	1,871.35	1,578.85	-292.49	-15.63
Land Use Type	Pudong			
	1991(km^2)	2010(km^2)	Change(km^2)	% of Change
Construction	208.07	293.36	85.283	40.99
Water Body	49.43	32.23	-17.21	-34.79
Agriculture	302.68	234.59	-68.08	-22.49

Urban land expansions in Jinshan and Nanhui are spatially scattered, while some are concentrated in coastal areas. Urban land expansion in Pudong is quite dissimilar from other districts. In 1991, most urban land in Pudong was concentrated in the area sideways of the Huangpu River. In 2010, urban land almost covered this entire district. We also found some significant agglomeration phenomenon in this process, which can be explained by the rise of development zones established by state policy and urban planning. To understand how state policies and municipal government influence urban land expansion in Shanghai, we evaluated the land use change of the DZs in our study area separately (Wei & Leung, 2005). In 2006, there were 12 national level DZs and 26 provincial level DZs in Shanghai. The total area of national DZs and provincial DZs were 209.02 km^2 and 431.85 km^2, respectively. In this study area, there were 180.71 km^2 and 332.26 km^2 national and provincial development zones, accounting for 86.45% and 76.94% of DZs' area in the Shanghai municipality, respectively.

To understand how state policies and municipal government influence urban land expansion in Shanghai, we evaluated the land use change of the DZs in our study area

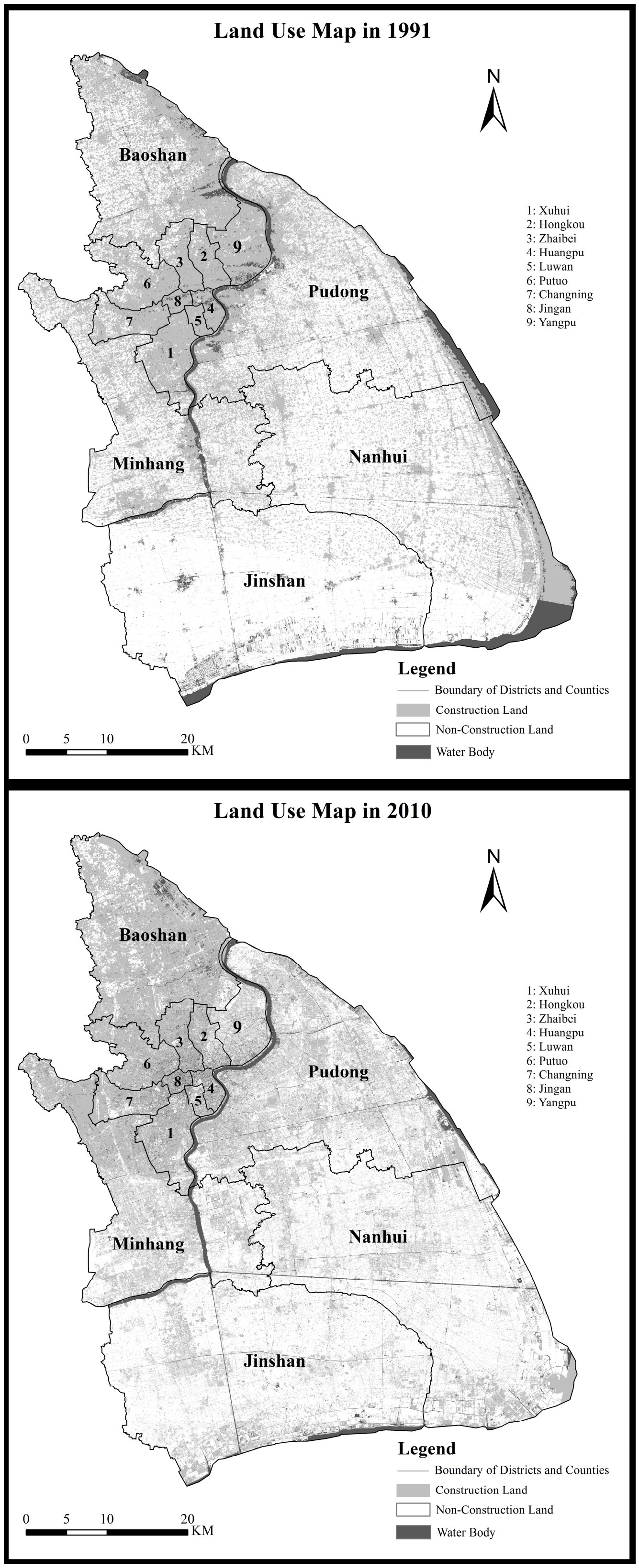

Figure 4-2 Land use map of eastern Shanghai in 1991 and 2010

In 2006, there were 12 national level DZs and 26 provincial level DZs in Shanghai. The total area of national DZs and provincial DZs were 209.02 km^2 and 431.85 km2, respectively. In this study area, there were 180.71 km^2 and 332.26 km^2 national and provincial development zones, accounting for 86.45% and 76.94% of DZs' area in the Shanghai municipality, respectively.

There is a more than 820% increase of construction land use in national level DZs, which is much higher than the average increase ratio of this study area (Table 4-3). In the national level DZs, more than 92% of water areas convert to construction land, because there are several significant coastal harbors built in these DZs. The increase of construction land in provincial level DZs is 102.20%, which is much lower than the rate in national level DZs, but still higher than the average level of this area. The total amount increase of construction land in DZs from 1991 to 2010 is 190.06 km^2, accounting for more than 50% of construction land increase of this study area. Thus, we suggested that the development of DZs plays the most significant role in urban development in Shanghai, and the development of national DZs occurs more quickly than provincial DZs because the hierarchy of state policy still plays a significant role in Shanghai's development (Wu, 2000).

Spatial Patterns of Urban Growth in Shanghai

Shanghai also has its unique spatial pattern in the expansion process. According to the patch analysis, three types of urban growth can be identified quantitatively: infilling, expansion and leapfrog (Figure 4-3).

Comparing these statistics with previous studies, we found that in different cities

Table 4-3 Land use change in DZs

Land Use Type	Amount(km^2)		Percentage of Total Change (%)		
National DZs	1991	2010	1991	2010	1991-2010
Construction Land	12.09	111.71	6.69	61.81	823.37
Nonconstruction	64.46	61.69	35.67	34.13	-4.31
Water Body	104.15	7.32	57.63	4.05	-92.97
Total	180.71	180.71	100.00	100.00	0
Provincial DZs	1991	2010	1991	2010	1991-2010
Construction Land	88.44	178.89	26.62	53.84	102.27
Nonconstruction	234.44	150.66	70.56	45.34	-35.74
Water Body	9.38	2.72	2.82	0.82	-71.05
Total	332.26	332.26	100.00	100.00	0

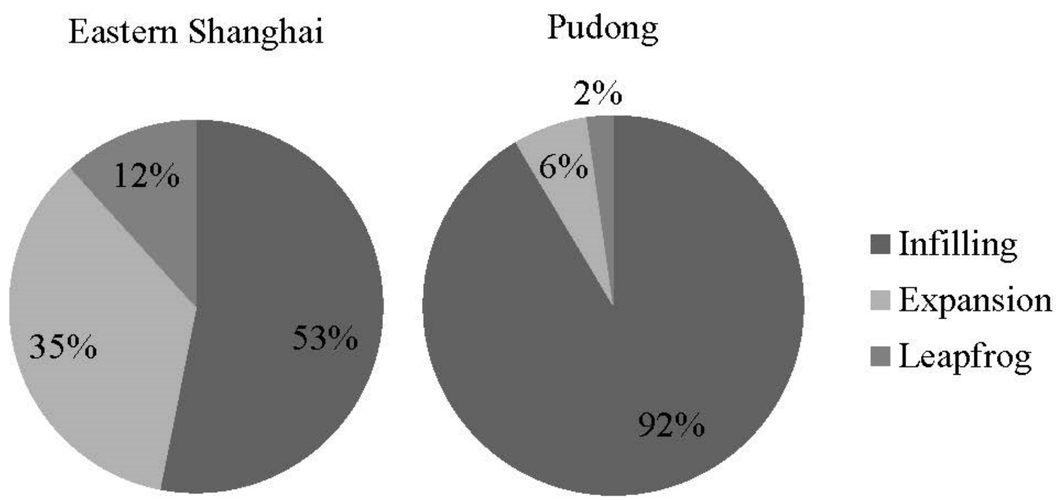

Figure 4-3 Percentage of spatial patterns in urban land expansion

with diverse economic and geographic conditions, the spatial patterns also vary. In eastern Shanghai and Pudong, the patterns named infilling and expansion comprises the majority at more than 88% and 92% of the conversion of construction land use, respectively. These results are significantly different with most other Chinese major cities. For example, in the polycentric development cities such as Nanjing and Hangzhou, leapfrog and expansion are the major patterns (Xu et al., 2007; Yue, Fan, Wei, & Qi, 2014), while in the town-based development cities such as Dongguan, leapfrog is the leading pattern of urban growth (Liao & Wei, 2014).

Spatial distribution of these patterns in our study area can be found in Figure 4-4. We found that, in the neighbor districts of the urban center area, the pattern is dominated by infilling. However, leapfrog mainly dominates some subadministration centers such as Nanhui and Jinshan, and some coastal areas. In 1991, the roads and some other basic infrastructures were already built in these areas, and development in the next 19 years has just filled the construction land in this network of roads and infrastructures. When the central and municipal authorities make site decisions for the DZs, the maturity of infrastructure conditions is one of the significant criteria. Consequently, the development patterns of DZs in Shanghai are expansion and infilling. The leapfrog parcels represent some land developments of the subdistricts, which are driven by the local government and non-SOEs (State-Owned Enterprises).

To examine the mismatches between real development and planning design of land use, we compared the patterns map below (Figure 4-4) with the land use planning map from 2000 (SPLRA, 2014), and found that they matched perfectly. There is not much leapfrogging of industrial land, and residential land use in Nanhui and Jinshan in the land use map, and all the planned construction land uses are defined and ranged by the roads. Based on the result of patch analysis, it is suggested that the urban development of Shanghai is under the strict control of urban planning and land use planning.

Determinants of Urban Growth in Shanghai

To avoid the multicollinearity problem of the afterward regression analyses, we tested the variance inflation factor (VIF) of all explanatory variables and found that all the results of VIF are smaller than 2, thus indicating that no pair of variables has a

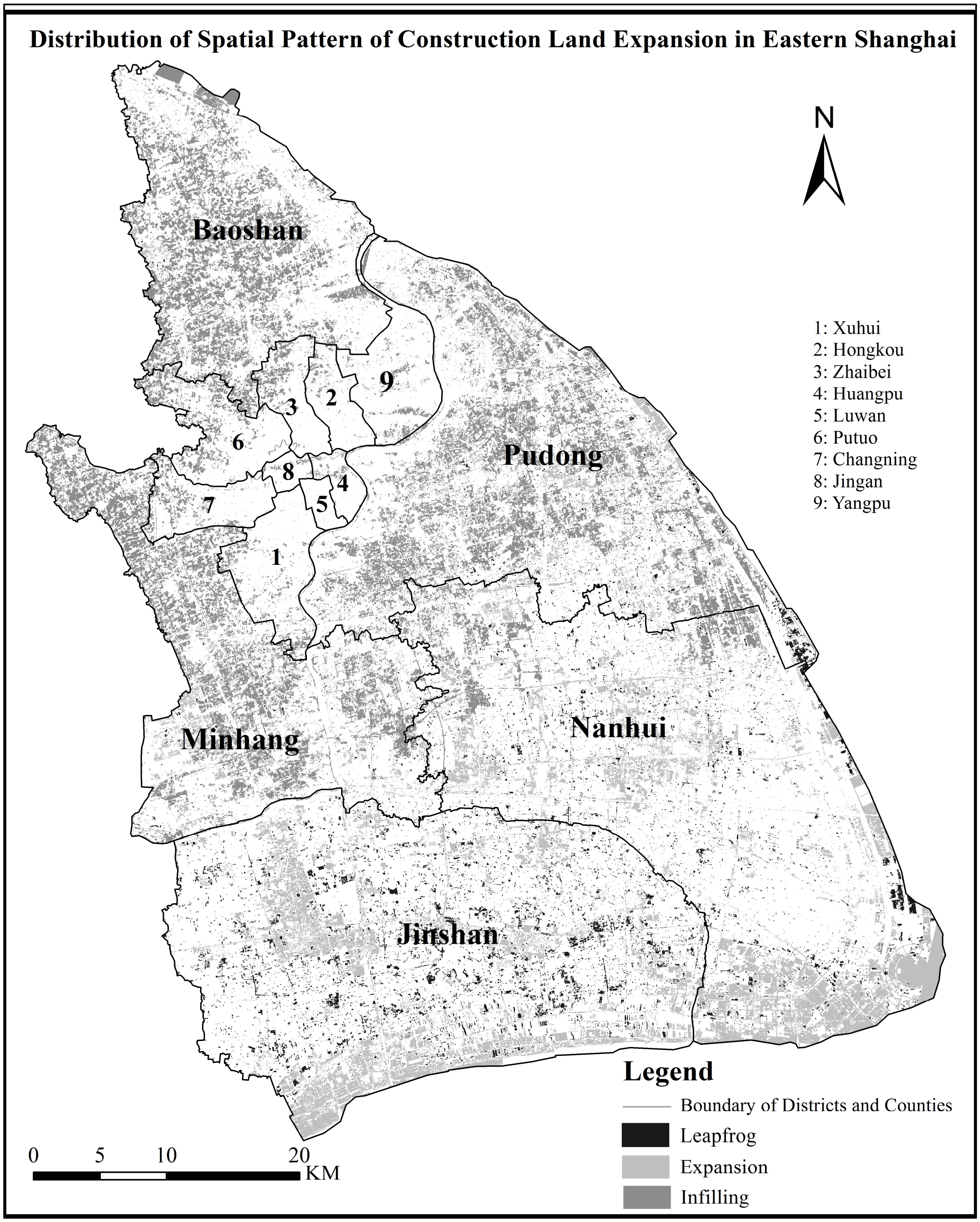

Figure 4-4 Spatial patterns of construction land expansion in eastern Shanghai

significant linear correlation. Table 4-4 represents the results of the global logistic regression and GWLR. The receiver-operating characteristic (ROC) results are larger than 0.8 for all the models, which are located in the convinced interval.

First, from the state power perspective, we found that the distance to railway (DRL) has the strongest negative effect on land conversion probability, which is different from the result of Nanjing and Wuhan (Cheng & Masser, 2003b; Luo & Wei, 2009). The distance to highways (DHW) and the distance to subway stations (DSWS) are insignificant, which can be interpreted as meaning that our study area is not a traditional transportation hub. The coefficients of distances to airports and ports (DAA and DPP) are also significantly positive, which represents the urban growth that occurs in the area further distant from airports and ports, to avoid pollutants such as noise.

The coefficients of DZs, planning areas and Pudong (VDZ, VP, and PD) should be highlighted, because these variables are the most significant indicators in demonstrating how state power influences the urban development in Shanghai. The coefficient of VDZ is 0.922, which is very significantly high as a dummy variable in the logistic regression. The parameter estimate of VP is also significantly high. The coefficient of PD is lower than VDZ and VP, but it is still very high. The results of these variables prove that our hypothesis, that state policy and planning, are the major driving forces of urban growth in Shanghai, which also matches with the conclusion of Wu in 1999, pointing to the strong government regulation in Shanghai.

Second, from the market power perspective, distance to local artery roads (DLW) is the most significant variable, which is similar to the findings of previous studies (Luo & Wei, 2009; Wu & Yeh, 1997).

Table 4-4 Global logistic regression and GWLR result

Area Variables	Global Logistic Coefficient	GWLR Mean Coefficient	GWLR Positive
	Market		
DLW	-0.174***	-0.219	22.17%
DEA	0.399	2.984	62.96%
DEC	-3.605**	-0.905	25.43%
DEW	1.069	3.391	67.29%
	Urban growth pattern		
DC	-0.096***	-0.076	0.00%
DSC	0.015*	0.012	86.47%
DHPR	0.092***	0.092	100.00%
	State		
VDZ	0.922***	0.903	Global Variable
VP	0.669**	0.661	Global Variable
PD	0.234**	0.304	Global Variable
DHW	0.014	0.020	62.93%
DRL	-0.042**	-0.065	0.00%
DAA	0.022**	0.013	72.06%
DPP	0.014**	0.016	90.04%
DSWS	-0.003	-0.021	31.28%
	Assessment		
Constant	1.354	-0.993	62.81%
AIC	3859.4	AIC	3754.4
Observations	3504	Observations	3504
ROC	0.802	ROC	0.834
Pseudo R^2	0.26		

Note: *** Indicate significance at 0.01 Level
** Indicate significance at 0.05 Level
* Indicate significance at 0.1 Level

The rise of proximity to city streets in land development is important in many large cities of China, and the coefficients of the density of agriculture land (DEA) and water (DEW) are both positive but not significant. These results imply that the potentiality and restriction are not important in Shanghai's development, because the development of DZs is decided by the local and central government, and attracts a huge amount of investment, which lessens the expense of the land conversion. Moreover, because Shanghai already had a stable large scale of the urban core in 1991, the land use expansion in this urban core should be relatively rare. In the study of Nanjing and Wuhan, the density of agriculture land is significantly positive, thus representing the potentiality of urban growth. Water area is one of the significant restrictions of urban growth.

Third, the local government of Shanghai proposed polycentric development as one of the major strategies of urban growth in its urban master plan in 1999 (SPLRA, 2014). However, our results reveal that expansion from just one city center is the principal spatial pattern of urban growth in Shanghai. For instance, among the urban growth pattern variables, distance to major city center (DC) has the strongest significant negative impact on the urban development, while the distance to subadministration centers (DSC) has a positive influence on the urban growth in this study area. These two variables imply that the pattern of urban development of this study area is individual-core, which matches the previous institutional studies (Timberlake, Wei, Ma, & Hao, 2014; Wu, 2000). The parameter of distance to the Huangpu River (DHPR) is significantly positive, which rejects the idea that Shanghai's development is along the Huangpu River.

We employed the GWLR to find out how spatial variations affect urban growth determinants. The results prove that all parameters vary across the study area with generally regular spatial patterns. Among the variables of the market, the most significant impact on urban growth is the distance to roads, with 22.17 positive percentages. In the different areas of our study, the neighborhood land use also performs the different impacts on the urban growth, because the positive and negative percentages are almost equal in this category, which implies that there are huge spatial variations in these variables' influence on urban growth in our study area.

Moreover, among the variables of state power, DRL has the lowest positive percentage of coefficients (0%), which is consistent with the result of global logistic regression. Other variables in the state category, such as DAA, DHW, and DPP, have different impacts on urban growth based on the spatial differences. Due to the introduction of the GWLR in this study, there are some decreases in coefficients of VDZ, VP, and PD. Furthermore, there is not a fixed pattern of influences on the distances to subadministration centers and Huangpu River. We could suggest that urban growth in Shanghai is about the distance to the major city center, in which 86.47% of coefficients are negative. Overall, regression models effectively explain the determinants of the probability of Shanghai from a global view and prove that both the state and market forces drive urban land expansion.

Determinants Change in Development Zones?

We employed spatial regime regression and GWLR to investigate the different dynamics across the DZs (Table 4-5). For the sample points inside DZs, we found that they are more sensitive to the variables of state infrastructure powers, such as distance to subway stations, highways, railways, ports, and airports, which match the infrastructure requirements of establishing a DZ (Table 4-5). The urban growth patterns variables indicate that the preferences of location choices of DZs are concentrated in the suburb, which is far away from the major city center and close to the subadministration centers. However, the urban growths in DZs are less sensitive to the variables of market power, in which only the DEC is marginally positive.

For the sample points outside of the DZs, we found that there was an apparent dissimilarity from the points inside of the DZs.

Table 4-5 Results of spatial regime and GWLR for DZs

Model	Spatial Regime		GWLR			
Categories	In	Out	In		Out	
Variables	Coefficient	Coefficient	Mean	Positive	Mean	Positive
			Market			
DLW	0.168	-0.21^{5***}	0.087	95.82%	-0.292	4.76%
DEA	1.411	0.518	8.807	94.18%	1.607	55.56%
DEC	2.87*	-3.344**	3.901	63.58%	-2.043	16.40%
DEW	0.355	1.385	7.983	87.46%	2.305	62.50%
			Urban growth pattern			
DC	0.008*	-0.099***	0.035	0.00%	-0.086	0.00%
DSC	-0.009	0.014*	0.011	82.54%	0.013	87.37%
DHPR	0.011	0.079***	0.074	100.00%	0.096	100.00%
			State			
DHW	-0.003*	0.043***	0.002	37.01%	0.0252	69.38%
DRL	-0.071***	-0.036***	0.079	0.00%	-0.062	0.00%
DAA	-0.009*	0.009	0.008	77.76%	0.015	70.72%
DPP	-0.016*	0.006	0.010	78.66%	0.018	92.80%
DSWS	-0.079**	0.015	0.058	0.00%	-0.012	38.66%
Constant	1.871		6.481	30.60%	0.306	70.41%
AIC	3866.8				3754.4	

Note: *** Indicate significance at 0.01 Level
** Indicate significance at 0.05 Level
* Indicate significance at 0.1 Level

The market powers determine the urban growth outside of the DZs. In both results of spatial regime and GWLR, we found that the DLW had a significantly negative influence on the urban land expansion in Shanghai. The variables DEA and DEC, which represent the cost of land conversion, are more consistent with the results of Nanjing and Dongguan (Liao & Wei, 2014; Luo & Wei, 2009). This category of land development is more sensitive to the distance of city center. However, in the variables representing state power, only the coefficient of DRL is significantly negative and the DHW has a positive influence, which is opposite of the result from points inside of the DZs.

Therefore, it is important to point out that the dynamics of urban growth vary across

DZs. The urban expansion outside the DZs is influenced more significantly by market variables, while the urban development inside of DZs is more likely to be controlled by the state variables.

Based on the parameter results for all the sample points, we developed three parameter surfaces to reveal the spatial variations of urban growth patterns in Shanghai. The method we employed is the inverse distance weighted (IDW) interpolation algorithm. IDW assumes that the surface is being driven by the local variation, which can be measured by the neighbor values (Luo & Wei, 2009), and hence, is an applicable approach in this research. Figure 4-5 presents the parameter surface of DHW, DSWS, and DLW with $100m^2$ cell size.

From Figure 4-5, one can see that DHW and DSWS have negative effects on the built-up area construction in the development zones than the outside area. On the other hand, DLW has a more negative influence on the land development outside of the development zones, which is opposite to the DHW and DSWS. As DLW represents the market power, and the DHW and DSWS represent the state power, Figure 4-5 describes the spatial distribution of the influences from these two forces on urban growth. It is clear that the influences of state power concentrate in the DZs, while the influences from the market decision are primarily located outside of the DZs.

Conclusion

As China modernizes and urbanizes, spatial patterns and determinants of urban growth in large cities have become a focus of research on land use change. China's urban growth is influenced by the economic transition in China, and some scholars study mechanisms of urban expansion from an institutional perspective and point out that state

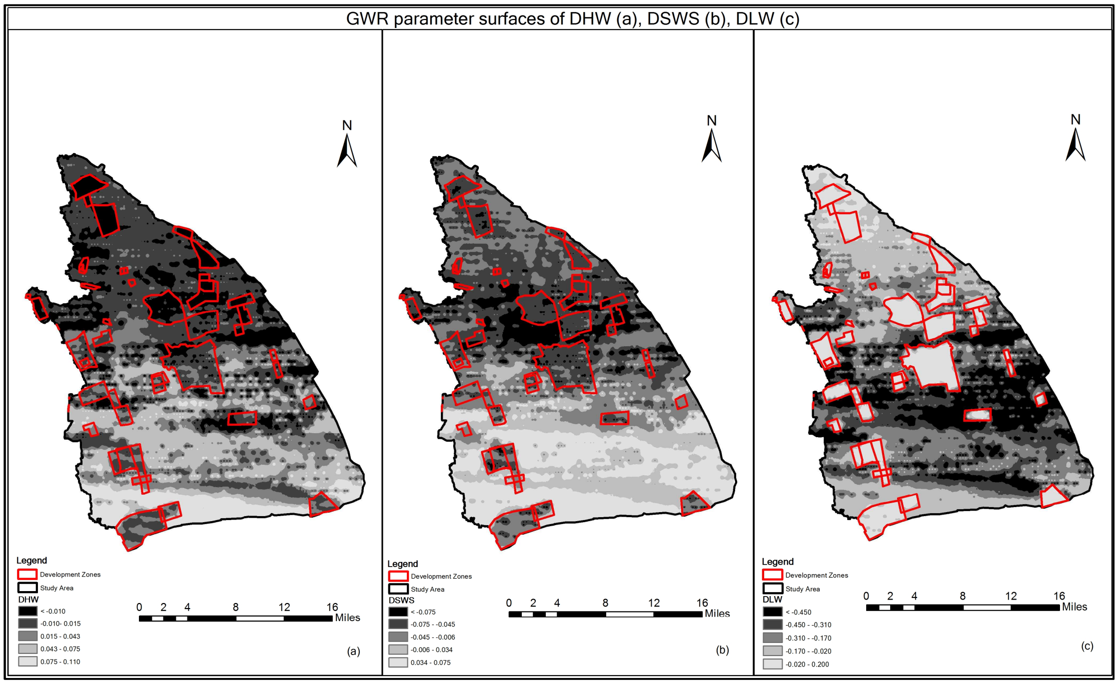

Figure 4-5 GWLR parameter surfaces of DHW, DSWS, and DLW

and market are the primary driving forces (Wei & Lin, 2002; Wu, 2000). Moreover, since the 1990s, supply-driven land development has been a major feature of Chinese cities (Tian & Ma, 2009), which introduced spontaneous unregulated land conversion. Although the control of land has been decentralized to district governments, land leasing in Shanghai is still under the strict control of the municipal government. Thus, urban expansion in Shanghai is being driven by local planning and state policy, such as the development of DZs. However, there are few quantitative results to support these findings, and more rigorous analyses are needed to quantify the mechanisms. Conversely, other scholars have attempted to analyze urban growth in China based on physical components, such as accessibility and neighborhood land use conditions, and they tend to deemphasize explaining urban growth patterns from an institutional perspective.

This study also analyzes spatial patterns and determinants of urban growth by patch analysis and logistic regressions. We found that major patterns of urban growth were infilling and expansion. For development zones, the increase of construction land use is influenced by the administrative hierarchy. The analysis of determinants of urban growth also proves that Shanghai is single-core based development and that both state and market play a significant role in urban growth. The spatial regime regression proves that the dynamics vary across DZs. Thus, considering urban growth as a comprehensive phenomenon, urban expansion in Shanghai is not only affected by the penetration of foreign direct investments and multinational corporations but also driven by local planning and state policy (Timberlake et al., 2014; Wu, 2000).

The findings have profound policy implications for land use planning. The analysis suggests that there is still a significant government involvement in Shanghai’s development. Urban land development in Shanghai is massive without considering the sustainability of economic development and environment protection. Furthermore, differences between mechanisms of urban growth for large Chinese cities also suggest that land use policies are fragmented. The gap between plan making and implementation is still a problem with urban growth. Further attention should be paid to the understanding of the extent and likely consequences of urban expansion under the dualism of plan and market. Current studies within GIS methods are mainly considering the physical dynamics of urban growth. More efforts should be made to incorporate socioeconomic processes to show the whole picture of mechanisms of urban land expansion in Chinese cities.

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CHAPTER 5

MODELING URBAN EXPANSION IN THE TRANSITIONAL GREATER MEKONG REGION

Abstract

Urban expansion in emerging urban areas has drawn plenty of attention. The Greater Mekong Region (GMR) has experienced dramatic urbanization and urban land expansion in recent decades. However, due to limited data availability and the complexity of political systems, few studies have focused on this area. Based on built-up area data from the World Bank compiled over the 2000-2010 period, this chapter integrates geographical, socioeconomic, and physical factors to explore the underlying patterns and dynamics of urban land expansion in the GMR. An explicit and critical emphasis is placed on institutional conditions. The growth of built-up areas in the GMR has concentrated heavily in the capital cities and coastal areas. Additionally, the transitional socialist countries have shown expansion that is more dramatic. Multilevel models suggest that urban developments in the GMR are not only sensitive to local contexts, such as distance to coastlines, topographic gradients and population growth rates, but are also closely associated with country-level factors, such as country political systems, economic growth patterns, and foreign investment.

Introduction

The connections between economic growth and urbanization have been globally reinforced (Bloom, Canning, & Fink, 2008; Fay & Opal, 2000). According to predictions by the United Nations (2011), millions of Southeast Asians will move to cities from rural areas in the coming decades. Besides this unprecedented demographic urbanization, urban expansion in Southeast Asia, which is highly associated with economic growth, resource allocation, inequality, social unrest, and sustainability, has also received intense scrutiny and attention from research and financial institutions, such as the World Bank and Asian Development Bank (Mertes, Schneider, Sulla-Menashe, Tatem, & Tan, 2015). As one of the most dynamic world regions and one on the cusp of growing regional economic integration vis-à-vis, the creation of the ASEAN Economic Community and the completion of myriad economic corridors crisscrossing the region, Greater Mekong Region (GMR) deserves further exploration of its urbanization and urban land expansion (ADB, 2011; Krongkaew, 2004). During the past decade, the GMR experienced rapid economic growth, and also witnessed dramatic urban growth in both demographic and landscape dimensions. From 2000 to 2010, the total urban population of this region increased from 38.5 million to 61.7 million, with an annual growth rate of 4.84% (World Bank, 2015), while the total population of this region increased from 297.14 million to 318.22 million, with an annual growth rate at 0.69%. The total built-up area of the GMR increased from 14,312 km^2 to 17,428 km^2 from 2000 to 2010, resulting in an annual growth rate of 1.99% (World Bank, 2015). Given the massive population residing in this region, as well as its various political systems (Krongkaew, 2004), a better understanding of urban expansion is critical to the urban development and sustainability of other developing countries in Asia. Moreover, since most Asian urban studies have focused on China, developing context-based and region-specific models to explain urban land expansion in the GMR also is crucial for testing the generalizability of the global theory of landscape urbanization in developing countries (Ma, 2002).

There has been a rich body of literature emphasizing the patterns and dynamics of urban land expansion in developing countries (Leinenkugel, Kuenzer, Oppelt, & Dech, 2013). Based on neoclassical theories, scholars have found that urban growth is determined by neighborhood land use types, accessibilities, and economic growth (Li, Wei, & Huang, 2014). Scholars adopting institutional perspectives have found that globalization processes influence urban land expansion, and that roles of state (Wei, 2005), patterns of economic transition (Huang, Wei, He, & Li, 2015; Li, Wei, Liao, & Huang, 2015), and entrepreneurship (Wei, 2012) also figure in urban land expansion outcomes. However, further study is needed which focuses upon the underlying determinants of these urban land developments, in particular, efforts which combine these institutional, socioeconomic, physical, and geographic components in to a joint explanatory framework. Moreover, the geographic and scalar variations of impact from these determinants, which are highly associated with spatial heterogeneity, also are not adequately considered in existing literature (Wei & Ye, 2014).

This chapter aims to explore the patterns and magnitude of urban land expansion in the GMR, based on the built-up area data from the World Bank over the years 2000 to 2010. As this research will demonstrate, the growth of built-up areas varies across the countries, and highly concentrates in the capital cities and coastal areas. The result of multilevel modeling suggests that urban developments in this region are not only sensitive to local determinants at the county-level, such as distance to coastlines, topographic gradients, and population growth, but also are closely associated with the country-level factors, such as the political system, pattern of economic growth, and penetration of globalization. Influenced by recent, often drastic economic reforms, the socialist countries of the GMR tend to have experienced more marked land development than capitalist countries of the region. By considering the underlying spatial heterogeneity of these determinants in geographically weighted regressions (GWR), we find that, demographic urbanization has a relatively smaller influence on urban land development in the GMR's socialist countries than in their market capitalist counterparts.

Literature Review

Scholars with specific interest in urban expansion of the GMR have concluded that population growth, shifting cultivation, and road-building are three of the most common cited causes of urban expansion in this region (Rowcroft, 2008). First, the increase in population in both rural and urban areas causes growing demand for construction land use and the building of ever more residential communities. The technological progress and institutional changes induced by population growth also contribute to the demand for construction land use. Second, existing studies have provided evidence that shifting cultivation drives urban land expansion in the GMR (Angelsen & Kaimowitz, 2001). To ward against poverty and famine, local governments in the GMR have encouraged residents to shift forestland to agricultural land (Contreras-Hermosilla, 2000; Turner & Meyer, 1994). This pattern of government sponsored forest clearing for cash crops, and the attendant settlement of migrants in cleared forest areas, has caused permanent deforestation, which has further invited the transformation of forest and agriculture land uses to construction land use (Lestrelin, Giordano, & Keohavong, 2005). The linkage between cultivation shifting and population growth has been well demonstrated in recent studies (Muller & Zeller, 2002). The increased population caused by cultivation shifting further raises the demand for built-up area for residential and commercial use. Lastly, similar to most developing regions, an extensive empirical body of literature strongly supports that development of roads contributes expansion of urban land in the GMR (Cropper, Griffiths, & Mani, 1999; Cropper, Jyotsna, & Griffiths, 2001).

Besides the more or less generalizable causes of urban land expansion in the GMR, local scholars have also generated explanations that feature region-specific social and economic mechanisms of landscape urbanization applicable in this region (Angelsen & Kaimowitz, 1999; Thongmanivong, 1999). Input prices, crop prices, labor availability and cost, and local technology have each been found to be significant determinants of farmers' and developers' decisions on shifting cultivation and road-building, which further influence urban land expansion in the region (Geist & Lambin, 2001; Muller, 2003). Moreover, such price, labor and technological factors are also highly associated with the processes of population and economic growth, market liberalization, globalization, and state intervention. However, these global concepts, which underlie urban land expansion in the GMR, have been mostly ignored in local urban studies.

Research Context and Conceptual Framework

Suitable political conditions are a prerequisite for rapid economic development, which is also the result of an interaction between globalization and local historical, cultural, and socioeconomic environments. China, Lao People's Democratic Republic (Lao PDR), and Vietnam represent typical socialist countries, adhering to a socialist doctrine, featuring a ruling communist or socialist political party, and the direction of a one-party dictatorship. As a typical capitalist country in the GMR, Thailand abolished the traditional monarchy in favor of a constitutional monarchy in 1932. The Cambodian People's Party (CPP) tightly holds the reigns of Cambodian state power by guiding the legislative process and intervening in legislative and judicial powers through financial grants. Its official parliamentary government system aside, from 1962 until very recently Myanmar has largely experienced military rule. These overarching types, however, mask the complexity, change and upheaval, which have typified GMR societies in the first decade of the 21st century. The political crises in Thailand, which peaked in 2005-06, and 2008-10, led to periods of great uncertainty, military rule, and waves of violent protest. In Myanmar, the 2008 constitutional referendum and 2010 elections were widely criticized as unfair and fraudulent (Neher, 2002).

China has witnessed a dramatic economic growth since 1978, marked by the economic reform from planned economy to market economy. Vietnam has approximated China’s mode of reform since 1986, when the 6th National Congress of the Communist Party promulgated *doi moi*, setting the country on a path toward a gradual transition from national central planned economy to a socialist-oriented market economy (World Bank, 2011). Similar to China and Vietnam, Lao PDR began to pursue economic reforms actively from planned economy to market economy in 1988. These economic reforms can be characterized by the establishment of free market economy, privatization of some enterprises, loosening control of state-owned enterprises, and efforts to attract foreign investment (Krongkaew, 2004). These characteristics also can be integrated into the framework of triple-processes that were first applied to explain China’s economic transition: decentralization, globalization, and marketization (Wei, 2001).

Penetration of global capital requires these socialist countries to change their economic system accordingly. Globalization grants these socialist countries great foreign investment to develop their industries. For example, in 2000, Lao PDR had more than 600 garment and shoe factories, and most of them were invested by foreign enterprises (ADB, 2011). Although Lao PDR, Vietnam, and China have top-down style political systems, decentralization can still be observed in their reforms (Wei, 2001). The decentralization includes an increase of local democracy and local governments’ legislative and financial autonomy. Among the advantages of centralized bureaucratic control is the capability to effectively and rapidly mobilize the country's human and material resources. However, because it often comes with limited understanding of local problems, a high of level centralization also frequently suffers from problems of inequality and corruption. Finally, marketization, also interpreted as privatization, becomes the most significant common feature in their reforms. For instance, Lao PDR’s government allowed local officials to develop their own enterprises from the 1990s, allowing for the development of a family-level economic component in the country’s Lao PDR economy (Neher, 2002).

The linkage between these triple-processes of economic reform and the expansion of urban China has been demonstrated convincingly in recent studies (Huang et al., 2015; Li et al., 2015; Wei & Ye, 2014). The land administrative systems in Lao PDR and Vietnam are similar to those in China, and land proprietorships belong to the local and central government. Local states transfer land use rights to developers in order to attract investments and gather land transaction fees that are, in turn, mostly used to develop the local infrastructure (Lund, 2011; Markussen, Trap, & Broeck, 2011). In light of these commonalities, we assume that this framework will also facilitate a clearer understanding of the urban expansion processes in Lao PDR and Vietnam, and in juxtaposition with the wider GMR. Decentralization will grant much authority and responsibility to the respective countries' local governments so that they are equipped to provide greater amounts of land for transferring, at the same time that globalization will integrate the local economy into the world economy, which, in turn, results in dramatic increases in the demand for industrial land use. At the same time, marketization also encourages urban land expansion through industrialization and the establishment of private enterprises (Wei, 2012). However, although economic transition and urban expansion have been witnessed in Lao PDR and Vietnam since the 1980s, there are few studies focusing on the linkage between the economic transitions and urban expansion for both countries, which might provide a more comprehensive explanation for various patterns and dynamics of urban land development in the GMR.

Based on the above literature review and discussion of research context, there are several broad areas deserving of additional academic inquiry. First, scholars have found that economic transition will be accompanied by a dramatic urban expansion in the socialist countries. However, because of lack of comparison with capitalist countries, the advantages of transitional socialist countries vis-a-vis urban expansion have not been fully revealed in the current literature. Second, although Lao PDR and Vietnam have approximated China's development patterns and pathways, there are few studies applying

Chinese context-specific theories on urban expansion in settings further afield within the region. Third, the combination of neoclassical and institutional perspectives in studies of urban growth warrants closer attention from scholars. Finally, although the body of literature on dynamics of urban growth is rich, due to the limited availability of data, there have been few studies focusing on the GMR.

Data and Methodology

Study Area and Data

The Mekong River stretches over several countries across Southeast Asia, ranking 27th regarding its basin area (816,000 km^2). The regional significance of Mekong River also is highlighted by the point that the Mekong basin is home to over 90 million inhabitants, to which the river system provides drinking water, irrigation, transportation, and energy. Besides the importance of Mekong River, the various political and socioeconomic environments also are beneficial for geographers testing their global urban economic theories. Therefore, we selected the GMR as our study area (Figure 5-1), which has two provinces in China and five independent countries, namely Cambodia, Laos, Myanmar, Thailand, Vietnam, the Yunnan, and Guangxi Provinces of China.
In 2010, this region had more than 2,500,000 km^2 land area (ADB, 2011). Based on the official administrative division of each country, there were 2471 county-level areas in the GMR in 2010: the third-level administrative division of Myanmar, Laos, Vietnam, Thailand, and Cambodia and the fourth-level administrative division of China, which also represent the 2,471 observations in our study. Myanmar had the largest land area, 676,000 km^2, consisted by 325 townships. Two provinces in China, Guangxi, and Yunnan had 225

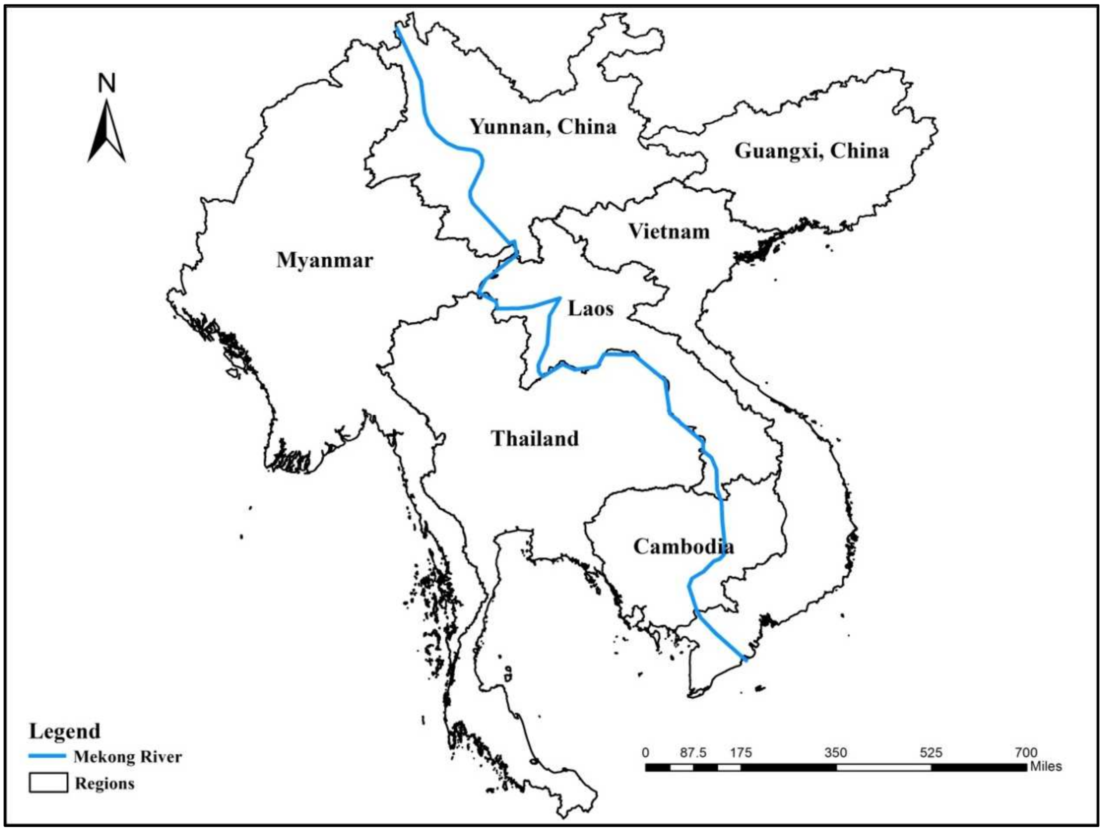

Figure 5-1 Study area: the GMR

counties, which covered more than 620,000 km^2 land area in 2010. There were 142 districts (*musings*) in Laos in 2010, whose average area for each county was 1,668 km^2. Vietnam had 674 districts (*huyens*), with a land area of over 331,000 km^2. Thailand had 514,000 km^2 in more than 900 districts (*Amphoes*), while Cambodia has 181,035 km^2 and more than 100 districts (*sorks*) (World Bank, 2015).

The data on urban land use and urban population in 2000 and 2010 were collected from the World Bank East Asia and Pacific Urban Flagship Study (PUMA). The data of built-up area from PUMA are the reclassification results of MODIS 500m map of global urban extent (Mertes et al., 2015). For the physical variables, the raster data such as digital elevation model (DEM) with a resolution in 90m and annual average precipitation surface with a resolution of one-degree latitude-longitude grids were collected from U.S.

Geological Survey (USGS) and Global Precipitation Climatology Project (GPCP), respectively. The stream and basin area of Mekong River was complemented by a database of World Resource Institute (WRI), while the socioeconomic data were completed based on the statistical books from various countries in 2001 and 2011, and national statistics from International Monetary Fund (IMF), World Bank and United Nations (UN).

Methods

To explore the determinants of urban land expansion in the GMR, we constructed two kinds of regression, multilevel regression and geographically weighted regression (GWR). The first one is the multilevel regression, also known as random-effect models, which has three levels (Eq. 5-1).

The multilevel models are employed to separate the effects of county-level characteristics and regional-level characteristics. Therefore, the one-level model is a pooled regression using county-level data including socioeconomic, physical and geographical indicators, while the two-level model adds the regional level variables. The within groups tests (the functions of RWG and AWG in R) suggests that there is a significant gap or heterogeneity between six national groups.

Moreover, considering the cross-section data for a period of 2000-2010 were adopted and country specific effects are uncorrelated with the urban expansion at each county, we controlled the random effects within the six national groups in the three-level model (Gelman & Hill, 2007).

$$y_{ijts} = \beta_0 + \beta_1 x_{ijts} + \mu_{oj} + \vartheta_{ojt} \qquad \text{(Eq. 5-1)}$$

Among the equation:

y_{ijts} refers to the dependent variable in county *i* that belongs to the country *j*

x_{ijts} is the independent variables in county *i* that belongs to the country *j*

μ_{oj} is the error term in country *j*.

ϑ_{oij} is the error term of *i* county that belongs to country *j*.

However, a global regression model can only represent the broad spatial trends and may mask significant local variations. Moreover, in the spatial autocorrelation test, we found that the global Moran's I is 0.406 with a significant value of z-score, which indicates there is strong spatial autocorrelation issue of urban land development in the GMR. To model the spatially heterogeneous determinants of urban land expansion and avoid the influences from spatial autocorrelation, we applied the GWR to measure the complex local variation of regression parameters (Eq. 5-2). The controversy for the biased result for GWR has been addressed in recent studies (Fotheringham, Brunsdon, & Charlton, 2002; Li et al., 2014), especially for sample size smaller than 200 observations. However, considering we have more than 4,000 sampled counties for the whole GMR, the adoption of GWR in this study to control spatial autocorrelation should be appropriate. Moreover, we tested and compared the global Moran's I of residuals in the models of OLS and GWR, and observed a significant decline. Detailed results are represented in the preceding sections. In its most basic form, the GWR model takes the following equation:

$$Y_i = C_i + \sum_k \beta_{ki} X_{ki} + \varepsilon_i \qquad \text{(Eq. 5-2)}$$

In which Y_i is an urban expansion to be regressed, C_i is constant, β_{ki} is the parameter for individual explanatory variable X_{ki} *(k=1, 2, 3… n),* ε_i is the error term. Two methods are usually employed to obtain weights: fixed and adaptive kernels. The results from fixed kernels will be influenced by the density of sample points because the fixed kernel function applies an optimal spatial kernel over the space (Fotheringham et al., 2002). For instance, in the area with spare data, the local variations may be overestimated, and for the area where data are dense, this approach may underestimate the local variations. The adaptive kernel function guarantees a certain number of nearest neighbors as local samples, which will better represent the degree of spatial heterogeneity. In this study, by replicating Li et al. (2014), we employed the adaptive kernel function, which is based on the Gaussian distance function in this study.

Variables

We used the absolute changes in the built-up area (2000-2010) from World Bank for all counties in the GMR as the dependent variable to measure urban land expansion in this area (Table 5-1). To integrate the influences from physical, geographic, socioeconomic, and institutional factors across scales, we included two scale-level categories of the explanatory variables in this study: county-level and regional level. For the socioeconomic components, we applied the urban population change from 2000 to 2010 provided by PUMA to capture the growth of demand in residential land use, while used the urban population density in 2000 to measure the availability of urban land for each county (Li et al., 2015). In the process of urbanization in Southeast Asia, scholars have found that urban primacy has become a significant characteristic because the most economical and urban activities are mainly concentrated in the capital area (ADB, 1997). For instance, the population lived in the Bangkok accounted about 54% population of Thailand in 2000.

Table 5-1 Variables

Abbreviations	Description	Type
	Response Variables	
BC	Built-up Area Change (2000-2010)	*Continuous*
	Explanatory Variables	
	County Level	
	Socioeconomic Indictors	
UPD	Urban Population Density in 2000 (person/km^2)	*Continuous*
UPC	Urban Population Change (2000-2010) (person)	*Continuous*
CA	Capital Region	*Dummy*
BA	Built-up Area in 2000 (km^2)	*Continuous*
	Geographic Indictors	
SL	Slope (degree)	*Continuous*
EL	Elevation (m)	*Continuous*
PR	Annual Average Precipitation (mm)	*Continuous*
DC	Log of (Distance to Coast)	*Continuous*
MRB	Mekong River Basin	*Dummy*
	Regional Level	
GDPC	Log of (GDP Change) (2000-2010)	*Continuous*
FDIC	Log of (FDI Change) (2000-2010)	*Continuous*
TSC	Transitional Socialist Countries	*Dummy*

Note: Log of is the natural logarithm.

Moreover, based on the experiences in China, we found that the foreign investments are more likely to be attracted by the cheap labors in the capitals (Wei, 2012). Therefore, to test whether this urban primacy also exists in the urban expansion, we added a dummy variable about the capital area in the modeling. The variable of built-up area in each county for 2000 also was added in the model to control the influences from the initial advantage of urban expansion (Huang et al., 2015).

On the side of physical variables, we used slope and elevation in the centroid for each county derived from the DEM to capture the construction cost of the built-up area increased and suitability of human activities. In general, a higher level of elevation and topographic gradient increases the construction cost and are not suitable for economic development, then has a negative impact on the urban expansion. The average annual precipitation over the period from 2000 to 2010, which was derived from the surface of precipitation, was applied to represent the proxy of the risk of flooding.

Geographically, as a global phenomenon, cities are more likely to concentrate in the coastal areas. Moreover, according to the growth patterns in most developing countries, the globalization has more penetrations in coastal areas than inland regions. Therefore, the variable of distance to the coastal line was conducted to test if the coastal area has more urban land development. The Mekong River Basin is subject to frequent flooding and water quality issues including acid sulfate soils and salinity intrusion, which have negative influences on urban expansion (Gassert, Rai, Reig, & Luck, 2012). On the other hand, the river basin also could be interpreted as a positive factor of urban growth by supplying more resources for people’s life, such as flows of commerce and traffic. To test if a county located in the Mekong River Basin will have a relatively slower or faster urban expansion process, we added a dummy variable to measure if the county is located in the Mekong River Basin.

Besides the county-level indicators, and due to the limitation of data availability in gross domestic productivity (GDP) and foreign direct investment (FDI) in each county, we added two socioeconomic indicators with different scales in modeling: country-level for Burma, Cambodia, Vietnam, Thailand, and Laos, province-level for Yunnan and Guangxi. The log of changes in gross domestic productivity (GDP) and foreign direct investment (FDI) provided by IMF and UN are used to capture the economic growth and globalization (Li et al., 2015). As we mentioned before, the institutional variations lead the different patterns of urban development. China, Laos, and Vietnam have experienced the similar socialist economic transition since the 1980s. To test if this socialist economic transition will lead more urban development and how the institutional component affects urban expansion in the GMR, we added a dummy variable about the transitional socialist countries in the model. For the counties belonging to China, Laos and Vietnam, we assigned this variable with a value 1 and for the other countries' counties, the value is 0.

Urban Land Expansion in the GMR

Facilitated by the economic reforms and globalization, the GMR witnessed a great process of urbanization and urban expansion during 2000 to 2010 (Table 5-2). Table 5-2 demonstrates the changes of urban population and built-up area in these five countries and two provinces of China. First, the GMR experienced a substantial urbanization in both demographic and landscape dimensions. The increase of urban population was much higher than urban land expansion, which implied the growth of urban population density.

Moreover, the demographic and landscape urbanization in the GMR differ across regions and political systems. Guangxi and Vietnam have the largest number of urban population growth during the first decade of this century. Both of these regions had more than 7.5 million increases in urban population. The smallest increase occurred in Laos and Cambodia, only 0.2 and 0.5 million people moved from rural area to urban area from 2000 to 2010, respectively. We also found that Laos, Guangxi, and Yunnan have the highest annual growth rate in the urban population, which are 11.61%, 8.98%, and 7.97%, respectively.

On the other hand, for the urban land expansion, the most significant built-up area increase occurred in Thailand and Vietnam. During 2000-2010, the growth of built-up area in Thailand was 749.40 km^2, while this number for Vietnam was 897.34 km^2.

Table 5-2 Urban expansions of the Greater Mekong Region in the region-level

Region	Built-up Area				Urban Population			
	2000 (km^2)	2010 (km^2)	Change (km^2)	AGR	2000 (million)	2010 (million)	Change (million)	AGR
Yunnan	1,584.72	2,148.62	563.90	3.09%	2.79	6.00	3.21	7.97%
Guangxi	1,704.87	2,294.86	589.99	3.02%	5.69	13.44	7.75	8.98%
Lao	162.17	222.72	60.55	3.22%	0.10	0.30	0.20	11.61%
Thailand	4,617.16	5,366.56	749.40	1.52%	9.30	11.80	2.50	2.41%
Cambodia	218.47	291.05	72.58	2.91%	0.90	1.40	0.50	4.52%
Vietnam	4,201.72	5,099.06	897.34	1.95%	15.00	22.60	7.60	4.18%
Myanmar	1,822.69	2,005.08	182.39	0.96%	4.70	6.20	1.50	2.81%
Total	14,311.8	17,427.95	3,116.15	1.99%	38.47	61.74	23.27	4.84%

Note: AGR is the abbreviation of annual growth rate.

Similar to the urban population, the highest annual growth rate happened in the Laos, Guangxi, and Yunnan. Myanmar had the relatively lower annual growth rate in urbanization and urban expansion in the GMR, which can be explained by conflicts between military groups caused by its 6,000 km of land borders.

The transitional socialist countries in the GMR had more significant urban land development in the first decade of 21st century. We found that Guangxi, Yunnan, Lao and Vietnam had total 2,111.78 km^2 growth of the built-up area, accounting more than 67% of the GMR. The annual growth rate of these four regions was 2.47%, which was much higher than other countries in this region. The similar phenomenon also can be observed in the urban population development, which had more than 6% annual growth rate from 2000 to 2010.

Figure 5-2 demonstrates the association between GDP increase and growth of built-up area in these five countries and two provinces. As we can see, the urban expansion coincided with economic development in all seven regions, and the slopes of economic growth and built-up area increase vary across regions (Figure 5-2).

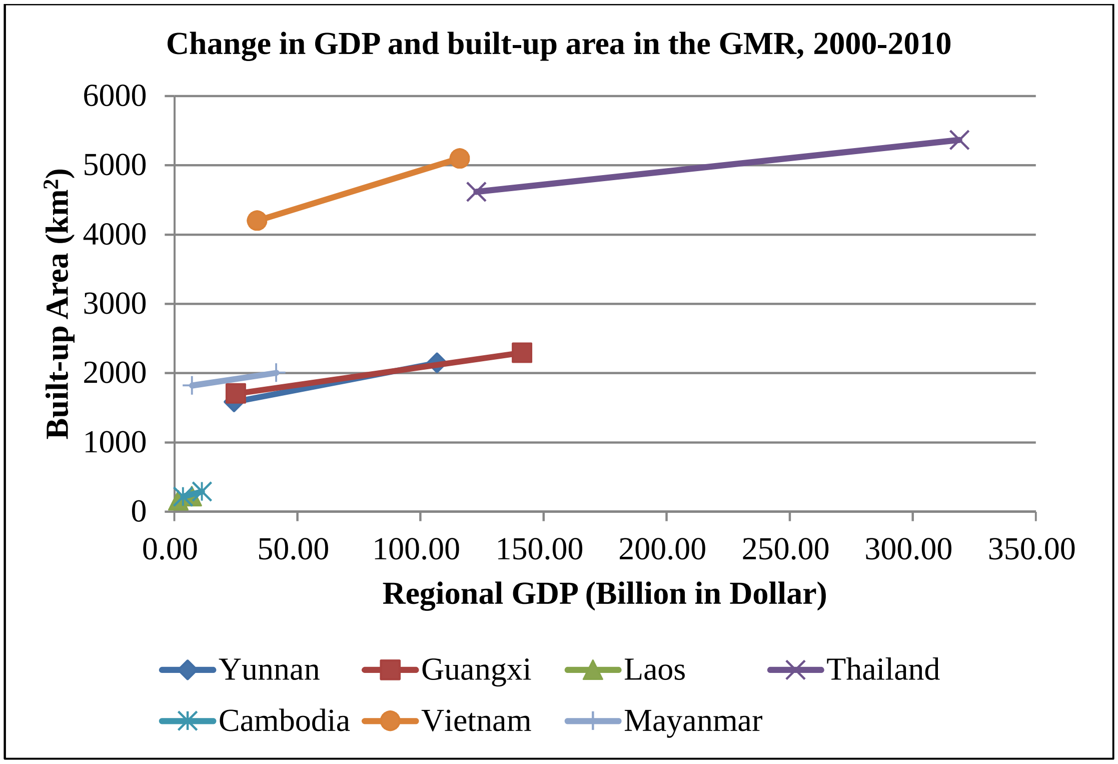

Figure 5-2 Change in GDP and built-up area in the GMR, 2000-2010

These differences reveal that the patterns and mechanisms of urban development in the GMR are different across political systems. The highest slopes occurred in four transitional socialist regions, namely Laos, Vietnam, Yunnan, and Guangxi, in which governments have the similar policies on the using urban expansion to promote the economic development (Lund, 2011; Markussen et al., 2011). Different from capitalist countries, the land proprietorships in China, Laos, and Vietnam belong to the government, and the local states transfer the land use rights to developers for attracting investments and gathering land transaction fees that mostly are used to develop the infrastructures. Therefore, the association between economic growth and urban expansion are tighter in these transitional socialist countries (Li et al., 2015).

We also found that urban expansion in the GMR varies across geography in county-level (Figure 5-3). Figure 5-3 demonstrates the spatial patterns of urban

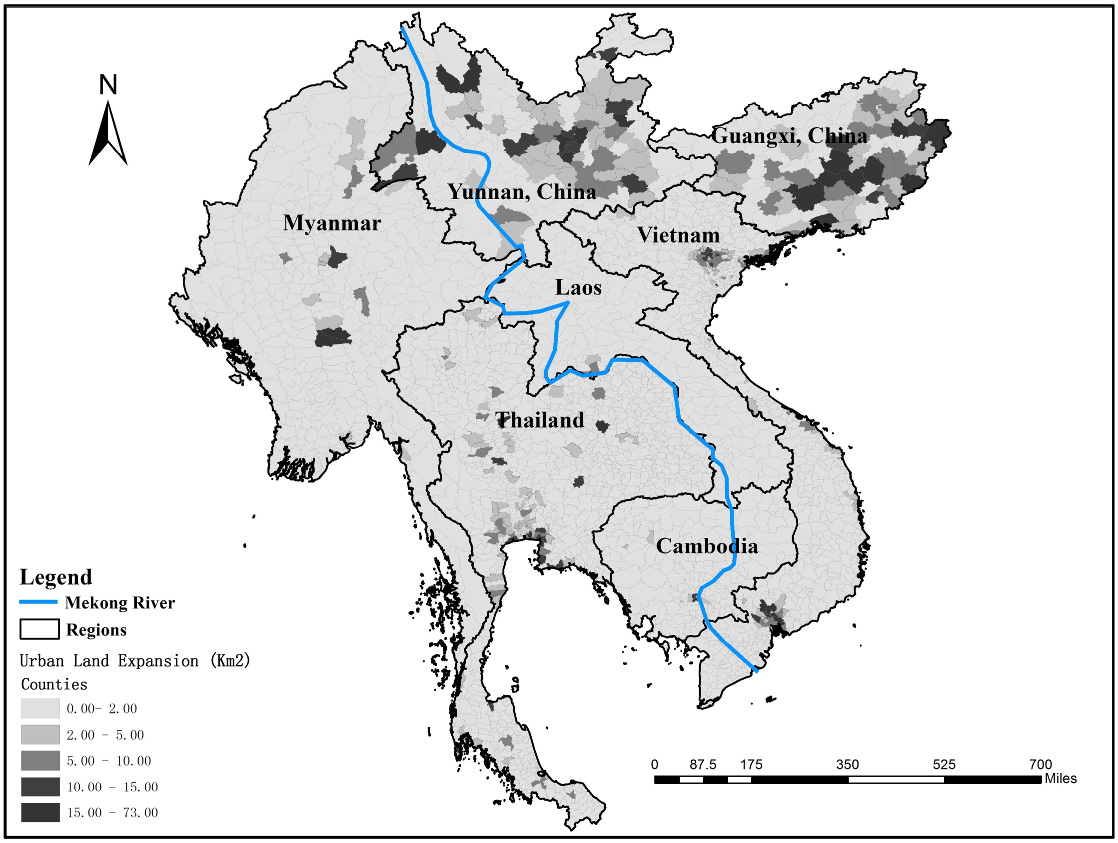

Figure 5-3 Urban land expansions in the GMR, 2000-2010

development in this region on the county-level, and these underlying inequalities of patterns might be able to be explained by the geographic and political components. Geographically, since the extent and area of Chinese counties are much large than the counties in other countries, we found that most land developed counties are more likely concentrated in the Yunnan and Guangxi of China. Vietnam's mountains and hills occupy three-quarters of the land area, and most urban developments are concentrated in the east coastal areas. Moreover, for Thailand and Guangxi province of China, most urban growth also is more likely occurred close to the coastal line, which represents the preferences of the foreign investments (Wei, 2012).

Besides the physical influences, the institutional components also play a significant role in the patterns of the GMR's urban expansion. We found that Vietnam's urban expansion is more likely occurred in the Hanoi and Ho Chi Minh City. Similar to Chinese urban administrative hierarchy, Vietnamese vertical management system has 59 provinces and five directly controlled municipalities: Ho Chi Minh City, Hanoi, Haiphong, Da Nang, and Can Tho. Most urban and economic development has concentrated in these municipalities since the economic reform in 1986. Additionally, the phenomenon of the urban primary in expansion also is observed in Laos and Cambodia, in which all the developments are concentrated in the capitals, the Vientiane, the only one municipality of Laos and Phnom Penh for Cambodia. Meanwhile, the urban land expansion of Thailand and Myanmar is more scattered than other countries, such as Bangkok, Phitsanulok, and Nakhon Sawan in Thailand, and Mandalay, Naypyidaw for Myanmar. For Myanmar, this is also interesting to observe that the newly established capital city, Naypyidaw, has been experienced a dramatic urban land development since 2000.

In addition to the previous findings which prove that the spatial heterogeneity exists in the urban land expansion in the GMR, we also found that the spatial autocorrelation cannot be ignored in the urban development of this area, by testing the global Moran’s I, whose value of is 0.406, with a significant p-value 0.05. After considering the global spatial autocorrelation, the result of Local Indicator of Spatial Association (LISA) was further conducted to explore the distribution of spatial autocorrelation (Figure 5-4). We found that the high-high clusters were most concentrated in Yunnan and Guangxi of China, and some coastal areas of Vietnam, Thailand, and Myanmar. The low-low areas are mainly located in the within borders of Laos, Myanmar, and Cambodia.

Overall, in the previous analysis, we found that the urban growth in the GMR differs across scalar, geographic and institutional variations, and the spatial autocorrelation and

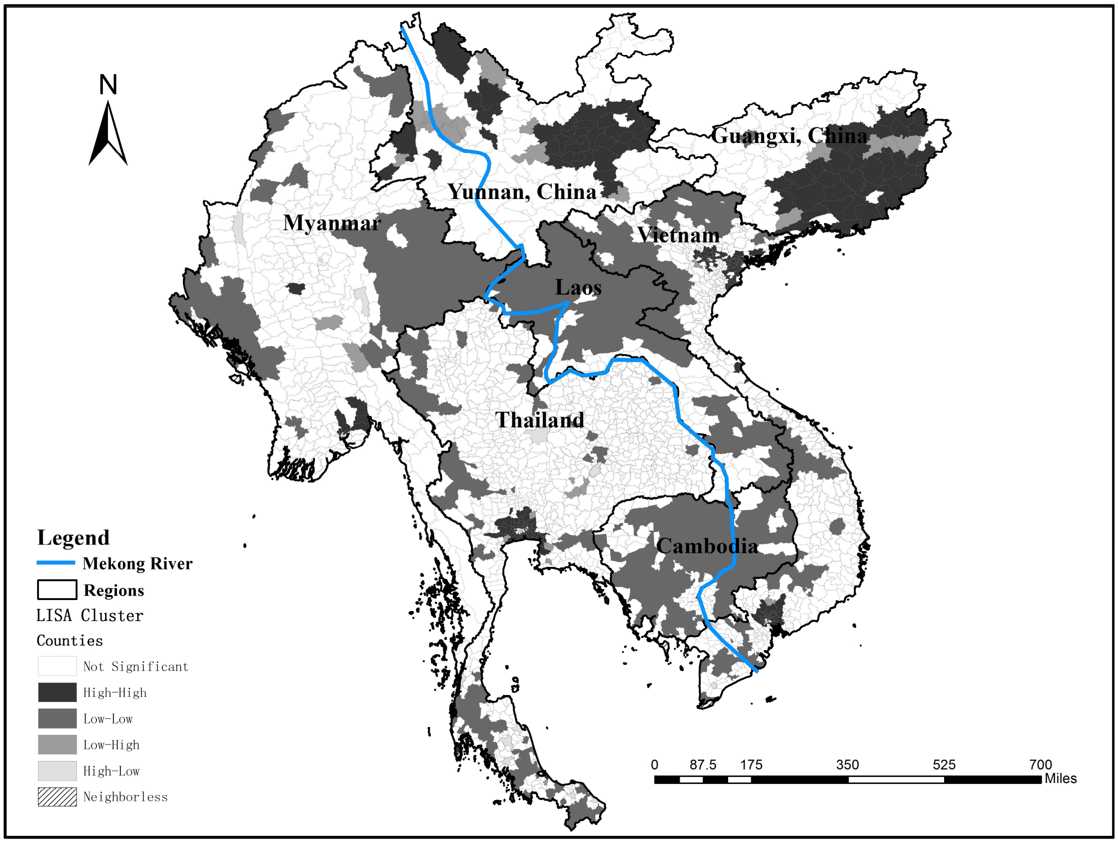

Figure 5-4 LISA of urban expansion in the GMR

heterogeneity exist in this growing process. Apparently, these spatial autocorrelation and heterogeneity are also intimately associated with the institutional and geographic profiles of each country. To explore the detailed associations between urban growth, and institutional conditions, geographic and other socioeconomic factors, the further investigation of the multilevel modeling and geographically weighted regression were applied.

Determinants of Urban Land Expansion in the GMR

The previous analysis confirms the spatial associations between urban population, institutional conditions and urban expansion in the GMR. We further employed the multilevel regression and GWR to test the underlying relationship between urban development and its expected determinants in a multivariate environment. To avoid the multicollinearity problem of the afterward regression analyses, we tested the variance inflation factor (VIF) of all explanatory variables and found that all the results of VIF are smaller than 3.0, which indicate no pair of variables has a significant linear correlation.

Table 5-3 represents the correlation analysis between variables. Generally, all the coefficients in the table are smaller than 0.75, which also imply that there is no multicollinearity problem in these models. It is not surprising that urban land expansion is strongly and positively correlated with the dummy variable of transitional socialist countries (TSC), given the fact that transitional socialist countries have more built-up area increase. The variables of urban population change and increase of FDI and GDP are also significantly related to the urban expansion, and these factors being proved as major driving forces of urban expansion in most studies (Huang et al., 2015; Li et al., 2015).

Table 5-4 reports model outputs for estimations of parameters of county-level and regional level variables for both multilevel regression and GWR. In the multilevel regression, the result of one-level model with county-level variables reveals that the urban population density (UPD), slope (SL), distance to coastal line (DC) and dummy of Mekong river basin (MRB) have significantly negative influence on the urban land expansion in this area (Table 5-4). Similar with our expectation, the coefficients of urban population increase, base-year built-up area and a dummy of capital regions are significantly positive. We added the regional level variables into the two-level model, and found that the variables of FDIC and GDPC have significantly positive impacts on the urban development in GMR, which also are in line with the previous literature about the relationship between urban growth and economic growth (Fay & Opal, 2000).

Table 5-3 Correlation coefficients among independent variables

	BC	*UPD*	*UPC*	*CA*	*BA*	*SL*	*EL*	*PR*	*DC*	*MRB*	*GDPC*	*FDIC*	*TSC*
BC	1												
UPD	-0.01	1											
UPC	0.49*	0.50*	1										
CA	0.21*	0.31*	0.28*	1									
BA	0.72*	0.06*	0.54*	0.22*	1								
SL	-0.02	-0.08*	-0.09*	-0.03	-0.11*	1							
EL	0.03	-0.01	-0.02	0.03	-0.01	0.30*	1						
PR	0.14*	-0.01	0.16*	-0.08*	0.16*	0.05*	-0.07*	1					
DC	0.05*	-0.13*	-0.07*	0.02	-0.04*	0.27*	0.44*	-0.07*	1				
BR	-0.16*	-0.09*	-0.16*	-0.06*	-0.19*	-0.12*	0.04*	-0.30*	0.24*	1			
GDPC	0.06*	0.01	0.04*	-0.09*	0.12*	-0.12*	-0.04*	0.07*	-0.02	-0.25*	1		
FDIC	0.15*	-0.01	-0.10*	-0.14*	-0.09*	-0.27*	-0.19*	-0.05*	-0.29*	-0.02	0.73*	1	
TSC	0.16*	0.06*	0.20*	0.05*	0.12*	0.24*	0.09*	0.52*	0.02	-0.09*	-0.18*	-0.34*	1

Note: represent the significance level of 1%*

Table 5-4 Estimations of regression

Variables	MultiLevel Regression			GWR	
	One-Level Coefficients	Two-Level Coefficients	Three-Level Coefficients	Mean Coefficients	Positive Percentage
Intercept	-2.11***	-3.91**	-1.11	-0.516497	45.57%
County-Level					
UPD	-0.00017***	-0.00017***	-0.00017***	-0.00042	0.00%
UPC	0.000037***	0.000036***	0.000037***	0.00013	100.00%
CA	1.13***	1.06***	1.11***	0.26	63.09%
BA	0.22***	0.21**	0.21***	0.056	50.30%
SL	-0.044**	0.022	0.023	-0.0026	35.90%
EL	0.000044	-0.000092	-0.000032	-0.000024	37.76%
PR	0.059	-0.074	-0.088**	-0.053	41.32%
DC	-0.15***	-0.097*	-0.063*	-0.090	55.40%
MRB	-0.22**	-0.14*	-0.49***	-0.46	0.08%
Region-Level					
GPDC	*NA*	0.21**	0.12*	0.058	55.08%
FDIC	*NA*	0.19*	0.21	0.065	48.93%
TSC	*NA*	0.27**	0.37	0.21	54.92%
Evaluations					
Observations	2471	2471	2471	2471	
R-squared	0.560	0.564	*NA*	0.735	
AIC	11915.80	11901.92	11867.48	10801.34	

*Note: *** Indicate significance at 0.01 Level*
*** Indicate significance at 0.05 Level*
** Indicate significance at 0.1 Level*

Moreover, for the variable representing transitional socialist countries, we found the coefficient is significantly positive, which reinforces our hypothesis and findings in the previous sections. It indicates that transitional socialist countries lead to an extreme urban expansion in the GMR and that the effect on from the institutional control and promotion still cannot be ignored.

The three-level model was developed to control the effects within the six national groups. We found there is a significant decline of Akaike information criterion (AIC) from two-level model to three-level model (Table 5-4), which indicates that controlling the random effect from nation groups improves the model, and the spatial heterogeneity does have an influence on the stationary assumption of this model. The three-level regression fairly confines the influences of the economic growth and population growth by comparing with the two-level model.

After the global regression with control of spatial heterogeneity, we applied GWR to control the spatial heterogeneity and autocorrelation to achieve a local estimation of the coefficient for each variable. The significant decrease of AIC and the apparent increase of R^2, from 0.564 to 0.735 (Table 5-4), imply that the control of spatial heterogeneity and autocorrelation improves the model. The results of GWR reveal the comparable determinants with the hierarchal linear model. However, it provides a more comprehensive interpretation of spatial heterogeneity of determinants. For most variables, the positive percentage of coefficients is about 50%, which implies that the geography plays a significant role in determining the association between urban expansion and physical, socioeconomic and institutional factors.

In addition to the global determinants unfolded by the Table 5-4, Figure 5-5 demonstrates the underlying geographic variations after these determinants. From the perspective of economic components, we found that FDIC and GDPC have different patterns in influencing urban expansion in the GMR (Figure 5-5). Apparently, the change of FDI has more influences in coastal areas of Thailand, Myanmar, and Vietnam, and some border regions between China and Myanmar, Laos, and Vietnam. Oppositely, the influence from GDPC is concentrated in the inland area of Vietnam, Cambodia, and Thailand.

We also found that the increase in urban population has different effects on urban land expansion across locations.

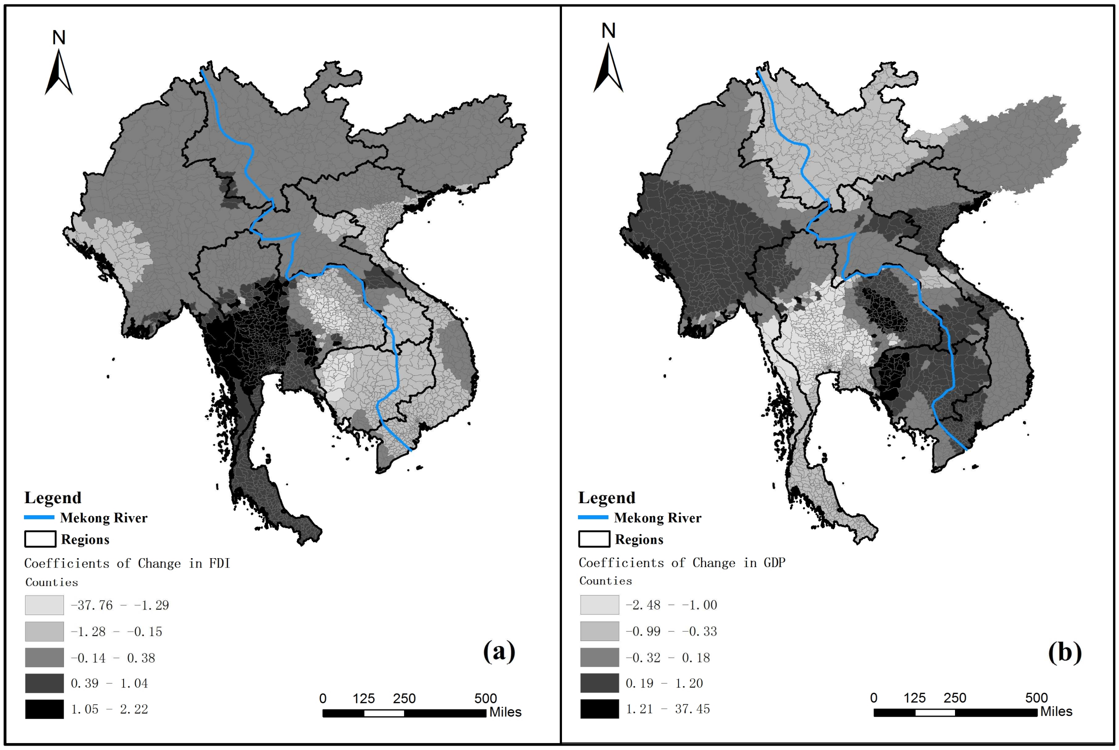

Figure 5-5 GWR parameter surfaces of FDIC (a) and GDPC (b)

According to Figure 5-6, urban population growth has a most positive influence on urban land expansion in Thailand, which is following the patterns observed in the countries of capitalism and free market system. This result is highly consistent with the hypothesis of determinants of urban land development in Western countries that the growth of urban land is major driven by the demographic urbanization (Fay & Opal, 2000). However, considering that the landscape urbanizations in these transitional socialist countries are driven by the land financed based institutional behavior, the migration from urban to rural areas should not be a most significant factor of urban expansion. For example, Scholars have concluded that the landscape urbanization in China is more likely to be accordance with the demographic urbanization (Bai, Chen, & Shi, 2011). This hypothesis also is proved in our study. The urbanization has a relatively smaller influence on urban land development in Guangxi, Yunnan, and Vietnam than Thailand.

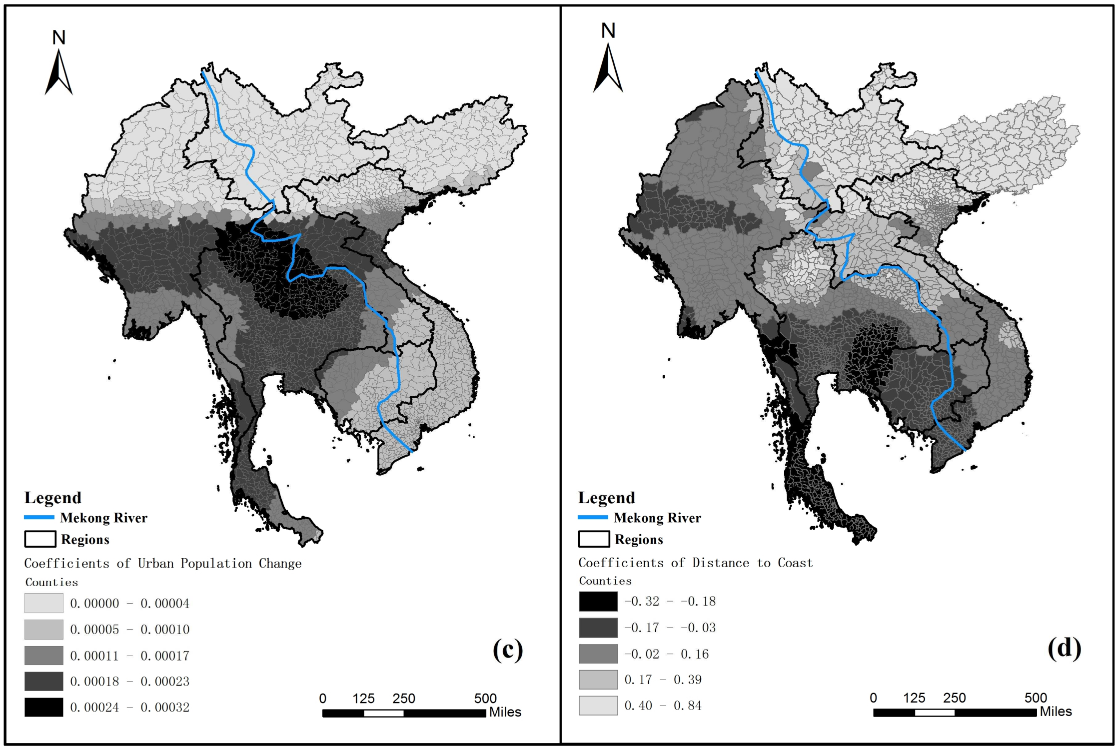

Figure 5-6 GWR parameter surfaces of PC (c) and DC (d)

The influence of a variable of distance to the coastal line also has spatial variations. We found the distance to the coastal line has more influences in the coastal areas, especially in the most south area of Thailand, from the Bangkok to the Greater Hat Yai-Songkhla Metropolitan Area. From the perspective of physical conditions, we found that the elevation had a negative influence in the coastal area and the riverside of the Mekong in Guangxi, Vietnam, Cambodia, and Thailand. The explanation is the high elevation prevents the damage from floods, tsunamis, and typhoons (Figure 5-7). Moreover, higher slope represents the high cost and more difficulties in construction, which should have a negative influence on the urban development. Geographically, in the north area of Guangxi and Yunnan that is close the Himalayas Mountain, the built-up area expansions are most significantly influenced by the slope.

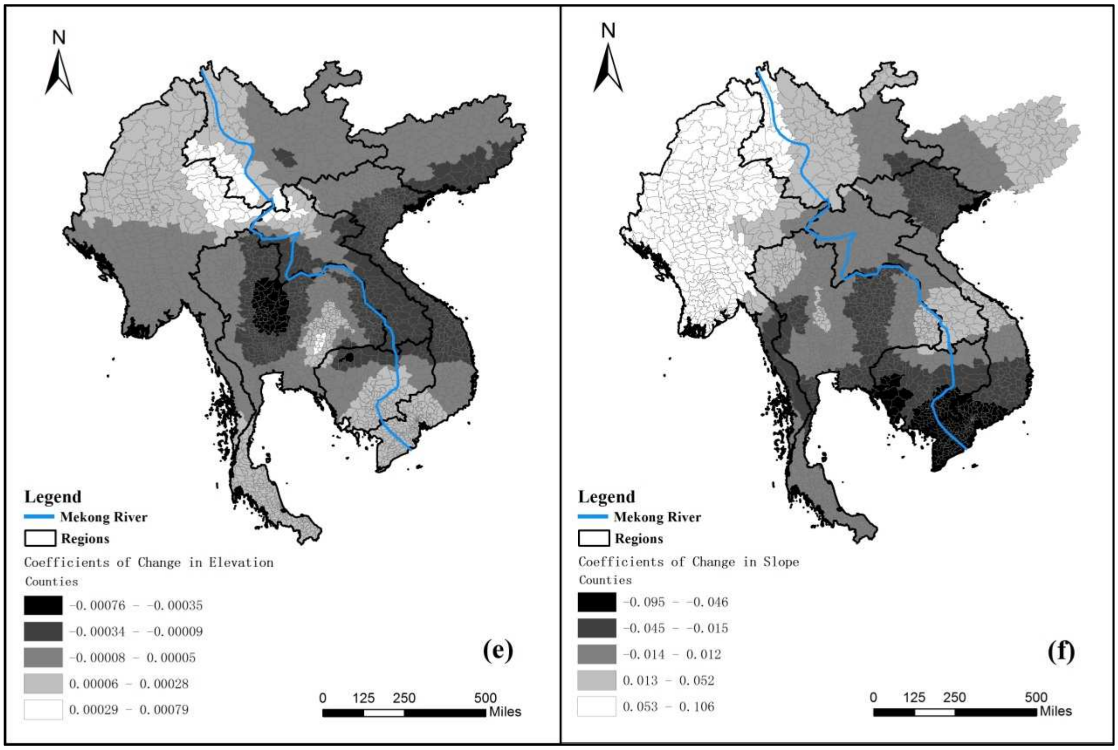

Figure 5-7 GWR parameter surfaces of EL (e) and SL (f)

Overall all, these two models reveal that urban growth in the GMR is not only sensitive to physical conditions which influence the construction cost of the conversion process from agriculture and forest land use to a built-up area but also highly associated with the economic growth, urbanization process, and political system. Moreover, although all the physical, socioeconomic, political, and geographic conditions influence the development of the urban area, the dynamics also have spatial variations. Due to different institutional and geographic circumstances, the determinants of urban land expansion differ.

Conclusion and Discussion

In the GMR, the land is being rapidly converted from agriculture and forest uses to urban use. As fuel and carrier of economic development, urban land has become an important instrument of development to eliminate poverty. The GMR has various political, geographic, and socioeconomic conditions, which becomes a perfect example to test the global existing theories of urban land expansion. Moreover, the institutional indicators are always difficult to quantify and to be integrated into modeling, and the governmental variations of the GMR also provide a rare chance to consider and exam more complicated institutional factors in land use models (Wei & Ye, 2014). Different from previous literature, this paper quantitatively investigates the association between the geographic, political, socioeconomic, and physical condition and urban land expansion in the GMR under the context of globalization and development of a variety of political system (Ma, 2002).

The patterns of urban land expansion differ across scales and locations, and the magnitude of urban expansion coincides with a country's political system. Urban expansion in the GMR is driven by the mixed determinants including economic and population growth, globalization, institutional efforts, and physical environment. Furthermore, the linkages between urban land expansion, elevation, globalization, growth of economy and population are sensitive to the institutional and geographical circumstances. Theoretically, this paper integrates the perspectives of neoclassical and institutional economics and combines the geographic, socioeconomic, and physical factors to explore the impetus after urban expansion in the GMR, by applying China's development mode and theories on other transitional socialist countries, such as Laos and Vietnam. Our study not only fulfills the literature gap of urban land expansion in the GMR but also tests the universality of global theories, which is hypothesized from experiences of urban growth in Western countries and selected developing countries.

Finally, this study could be improved by more fully taking into account more physical and socioeconomic drivers. For instance, recent research has tried to address how the climate change and extreme weathers influence the urban development (Silva & Matyas, 2014; Silva, Matyas, & Cunguara, 2015; Yuen & Kong, 2009). As a sensitive area to the earthquake, global climate change and floods influence, linking the earthquake and extreme weather and urban development in the GMR may have potential to improve our understanding further and connect the physical conditions and human behavior more forcefully (Costa-Cabral et al., 2008; Smith, 1971). Moreover, because of limitation of statistics of county-level in these regions and countries, more efforts could be made by integrating detailed variables to study urban land expansion in the GMR.

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CHAPTER 6

DISCUSSION AND CONCLUSION

With the dramatic economic growth and urban development in China in the last 35 years, China's urban land expansion has attracted more and more attention from scholars and policymakers (Lin, 2007; Wei, 2012, 2015). Numerous studies appear in this field for better understanding the pattern, process, and mechanism of China's urban growth. Moreover, these intensive transformations in urban landscapes of China have also provided a perfect laboratory in which GIS and spatial modeling techniques are found to be applicable. However, since the institutional components and the processes of economic transition are difficult to assess and quantify, the relationships between institutions, economic transition, and urban growth still deserve further investigation.

First, in the case of China, the magnitude of urban land expansion is not purely driven by capital inflows or rural-urban migration. Local governments have been playing a proactive role in this process (Wei, 2012). The neoliberal interpretation of land development in China, which tries to understand the mechanisms of urban land expansion in China merely from a neoclassical perspective, might be oversimplified and determinative since it ignores some fundamental and political conditions of China (Friedmann, 2006). For instance, in previous literature, although the relationship between urban land development and the administrative system appears to be self-evident (Lin, 2007), the extent to which they interact with other expansion determinants remain poorly understood. In addition, the interaction between state and the market has been identified as a significant impetus for both urbanization and urban land expansion in China. Moreover, geographical and categorical variations underlying these two forces still are uncovered by existing literature. Moreover, scholars have also pointed out that the triple-process of decentralization, marketization, and globalization results in shifting of Chinese states and economy (Wei, 2007). Considering the land development are closely associated with transitional state and economy in China (Lin & Ho, 2005; Lin & Wei, 2002), more work is needed on China's urban development mechanism in relation to economic transition.

Second, methodologically, the measurement of urban land expansion is monotonic, which is dominated by the absolute change of construction land use and built-up areas. These indicators fail to control the influences from the structural advantage and national development and capture the features of subcategorical land use change, such as industrial, transportation, and urban land use (He, Huang, & Wang, 2013). More studies are needed by focusing the mechanisms of China's land structure change in the process of urbanization and urban expansion. On the other hand, most conventional land use models only reveal global urban growth, but the same set of underlying factors may produce various effects. It is important to exploring the spatially varying relationships between land use change and influence factors at multiscalar levels.

Third, the theoretical framework and methodological inventions adopted from China's model also are needed to expand to other socialist and developing countries to prove the universality of the studies focusing on China (Li, Wei, Liao, & Huang, 2015;

Ma, 2002; Wei & Ye, 2014). Moreover, merely considering China as the study area may ignore how the political systems affect urban land expansion in a global extent. Therefore, extension of context-specific theories and methods to other socialist countries also is important to examine the generalities and advantages of China's development model.

To this end, this research intends to make up for these inadequacies by providing a quantitative understanding of the links between urbanization, urban expansion, economic transition, and institutions in several key ways. It explains the underlying processes of urban land expansion at both the national and municipal scales and shows that socioeconomic and institutional factors across administrative levels and geography exert fundamental influences on urban land expansion in China and other similar socialist countries. Four key findings can be summarized from the analysis of the above chapters.

First, the magnitude of urban expansion coincides with a city's administrative rank, and the relationships between urban land expansion, the economic transitions, the growth of the economy and population are sensitive to a city's rank. First, urban expansion in China is driven by mixed powers including economic transition, local state effort, economic growth, and population growth. Second, high-level cities' urban expansion in China has been more likely to be associated with FDI, characterizing the significant impact of economic globalization on urban expansion in these cities (Wei, 2012). By contrast, the establishment of DZs and fixed assets investments are closely related to urban expansion for all prefectures, echoing the notion of development zone fever and investment-driven expansion model in China. Therefore, model results prove the self-evident relationship between urban hierarchies and the land expansion in Chinese cities, which have been presented in previous qualitative studies (Li et al., 2015; Lin &

Ho, 2005; Ma, 2002).

Second, most construction land increase concentrates in the eastern region of China. Moreover, determinants of land use change differ across locations, study periods, and land use types. For urban land use, urbanization is the most significant driving forces, while, for industrial land use, FDI, and industrial restructuring, geographic factors are the dominant impetus. The regional transportation land changes are sensitive to the process of decentralization and the variables of accessibility. Our model results advance our understanding of regional urban land use change, not only highlighting the spatial patterns of this process but also demonstrating the well-documented driving forces based on the economic transition background (Huang, Wei, He, & Li, 2015).

Third, the major patterns of urban growth in Shanghai are infilling and expansion (Li, Wei, & Huang, 2014). For development zones, the increase of construction land use is influenced by the administrative hierarchy. The analysis of determinants of urban growth also proves that Shanghai is single-core based development and that both state and market play significant roles. The spatial regime regression proves that the dynamics vary across DZs. Thus, considering urban growth as a comprehensive phenomenon, urban expansion in Shanghai is not only affected by the penetration of foreign direct investments and multinational corporations but also driven by local planning and state policy (Timberlake, Wei, Ma, & Hao, 2014; Wu, 2000).

Fourth, urban expansion in the GMR is driven by the mixed determinants including economic and population growth, globalization, institutional efforts, and physical environment. The linkages between urban land expansion, elevation, globalization, the growth of economy and population also are sensitive to the institutional and geographical circumstances. By applying China's development mode and theories on other transitional socialist countries, such as Laos and Vietnam, this result not only fulfills the literature gap of urban land expansion in the GMR but also tests the universality of global theories hypothesized from experiences of urban growth in Western countries and selected developing countries.

The above findings have both theoretical and policy implications. Theoretically, this research goes beyond the existing view of the urban land expansion in China and spatial structure evolution by introducing the economic transition mechanism into the research debate, which concentrated on the institutional roles and economic growth model. The study also contributes to the debate about the mechanism of land expansion in China, by combining components of market and state. By introducing the spatial shift-share analysis to the urban restructuring topic, this study further provides an innovative method and perspective to view and observe the urban spatial structure evolution on a larger scale. Finally, this study contributes to our expertise about the testing the influence of institutional components based on the quantitative methods.

From a policy perspective, the analysis illustrates a series of issues challenging China's policy makers. As land use decision making grows into the central issues of Chinese cities, the hierarchy of Chinese cities tends to reinforce the inequalities in land development in China and cause more tensions between different levels of cities. Reforming local land property rights regimes, changing constraint structures of local governments in the hierarchical system, and better design of land use and DZs' development policies beyond the rank-based system would be next focuses for reforming China's political system and for purposes of sustainable urbanization in the future.

The analysis also suggests that there is still a significant spatial inequality of construction land use structure between eastern regions and other regions. Regional urban land use developments sometimes are moderately massive without considering the sustainability of economic developing and protecting the environment. Furthermore, the temporal gaps of mechanisms of construction land use change also reveal that there is not a long-term and effective land use policy for Chinese local government. Such attention will further the understanding of a theoretical framework regarding regional construction land expansion and enlighten the detailed determinants for subcategories urban land use change.

The analysis suggests that there is a significant government involvement in Shanghai’s development. Land development in Shanghai is massive without considering the sustainability of economic development and environment protection. Furthermore, differences between mechanisms of urban growth for large Chinese cities also suggest that land use policies are fragmented. The gap between plan making and implementation is still a problem with urban growth. Further attention should be paid to the understanding of the extent and likely consequences of urban expansion under the dualism of plan and market. Current studies with GIS and remote sensing methods are mainly considering the physical dynamics of urban growth. More efforts should be made to incorporate socioeconomic processes.

Our results also reveal failures in the process of decentralization for most municipalities in China, which is caused by public service gaps between core and periphery areas. Chinese central and local governments have been devoted to decentralize job opportunities and residential distributions. The leapfrog developments, which mainly caused by the establishment of DZs, decentralize some manufacturing jobs from core to periphery areas. The expansion of highly dense residential areas has also become of major characteristics of China’s urban sprawl. However, the job opportunities are still relatively concentrated in the traditional urban centers. The high-quality public services and facilities, which are controlled and assigned by the other institutional track, are still highly centralized in the urban center areas. These two concentrations have caused the failures of decentralization in job opportunities and housing market. Therefore, it is important to break the monopolization of supply side for public service from local government and to introduce fully market mechanisms into the development and relocation of public service.

The study could be improved through four aspects: first, the study mainly emphasizes the influences of economic growth on urban expansion, while recent literature has been more concerned about the causality between economic growth and urban development in China (He et al., 2013). Second, in addition to a top-down approach to urban development in China, future work is needed by employing a bottom-up perspective and conducting more in-depth case studies of most influential municipalities behind China’s urbanization. Third, due to the limitation of urban land use data in county-level of China, this study concentrates on the urban development in the prefecture-level. Recent studies have paid enough attention to the county-level urban development in some developed provinces, such as Zhejiang and Jiangsu. Because of lacking the comparisons between different scales, the roles of scale in urban expansion also need more investigation. Fourth, because of lacking the time-dimension in the dataset, the analyses from the temporal side are missed in this study. In addition, a spatial-temporal analysis could be more informative if it used some techniques that can trace the structural break and policy shocks in a GIS environment (Duque, Ye, & Folch, 2015). Fifth, considering more physical and socioeconomic drivers could improve this study. For instance, recent research has tried to address how the climate change and extreme weathers influence the urban development (Silva & Matyas, 2014; Silva, Matyas, & Cunguara, 2015; Yuen & Kong, 2009).

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